Thesaurarium Mathematicæ,

OR THE

TREASURY OF THE MATHEMATICKS.

CONTAINING

Variety of usefull Practices in *Arithmetick*, *Geometry*, *Trigonometry*, *Astronomy*, *Geography*, *Navigation* and *Surveying*.

AS ALSO

The Mensuration of *Board*, *Glass*, *Tiling*, *Paving*, *Timber*, *Stone*, and *Irregular Solids*.

LIKEWISE

It teacheth the Art of *Gauging*, *Dialling*, *Fortification*, *Military-Orders*, and *Gunnery*: Explains the *Logarithms*, *Sines*, *Tangents* and *Secants*: Sheweth their use in *Arithmetick*, &c. To which is Annexed a Table of 10000 *Logarithms*, *Log-Sines* and *Log-Tangents*.

Illustrated with several *Mathematical Sculptures* on Copper Plates.

By *JOHN TAYLOR*, Gent.

——Deus regit Astra; ferumtur
Illius arbitrio Syderæ, Terra, Fretum.

LICENSED, *June* 26. 1686. *Rob. Midgley.*

LONDON,
Printed by *J. H.* for *W. Freeman* at the *Artichoke* next St. *Dunstan's* Church in *Fleetstreet*. 1687.

Vera Effigies
Johannis Taylor
F. H. Van. Houe, Sculp.

Thesaurarium Mathematicæ,

OR THE

TREASURY

OF THE

MATHEMATICKS.

CONTAINING

Variety of usefull Practices in *Arithmetick*, *Geometry*, *Trigonometry*, *Astronomy*, *Geography*, *Navigation* and *Surveying*.

AS ALSO

The Mensuration of *Board*, *Glass*, *Tiling*, *Paving*, *Timber*, *Stone*, and *Irregular Solids*.

LIKEWISE

It teacheth the Art of *Gauging*, *Dialling*, *Fortification*, *Military-Orders*, and *Gunnery*: Explains the *Logarithms*, *Sines*, *Tangents* and *Secants*: Sheweth their use in *Arithmetick*, &c. To which is Annexed a Table of 10000 *Logarithms*, *Log-Sines* and *Log-Tangents*.

Illustrated with several *Mathematical Sculptures* on Copper Plates.

By *JOHN TAYLOR*, Gent.

——Deus regit Astra; feruntur
Illius arbitrio Sydera, Terra, & Fretum.

LICENSED, *June* 26. 1686. *Rob. Midgley.*

LONDON,
Printed by *J. H.* for *W. Freeman* at the *Artichoke* next St. *Dunstan's* Church in *Fleetstreet*. 1687.

96340

To the Right Honourable

GEORGE

Lord *DARTMOUTH*,

Maſter of the Horſe to

K. James II.

Maſter General of His Majeſty's Ordnance and Armories, One of His Majeſty's moſt Honourable Privy Council, *&c.*

This ſmall *Mathematical Treaſury* is humbly Dedicated and preſented by

My LORD,

Your Honour's moſt humble

and obedient Servant,

John Taylor.

To the Right Honourable

GEORGE

Lord DARTMOUTH,

Master of the Horse to

K. James II.

Major General of His Majesty's
Ordnance and Armories, One
of His Majesty's most Hono-
rable Privy Council, &c.

THE PREFACE TO THE READER.

HOW *admirably profitable the ſtudy of the* Mathematicks *hath been to theſe* Britiſh Iſlands, *and to all other parts of the* Univerſe *in which any kind of good Learning hath been eſteemed and practiſed, is well known to all wiſe and judicious men. And indeed it is an undeniable truth, that among all humane* Arts *and* Sciences *whatſoever, the* Noble Science Mathematical *hath obtained the greateſt evidence of certainty, as being the* Queen *of Truth that impoſeth nothing on her Subjects but what ſhe proves by moſt infallible Demonſtrations.*

Now this prerogative reſults from the verity and perſpicuity of its Principles, which conſiſt of Definitions, Poſtulats *and* Axioms. *Hence comes it to paſs that all* Propoſitions *that are proved by thoſe moſt infallible* Precepts *are called certain*

demonſtrative truths; for which cauſe it hath been the endeavour of ſundry Philoſophers *to make the force of their Arguments (as far as the quality of their diſcourſe would admit) amount unto* Mathematical Demonſtrations, *as being the moſt convincing proof of a* Propoſition *that by humane reaſoning can be given.*

Now having for divers years (amongſt my other Studies) been converſant in the ſtudy of the Mathematicks, *and for my own private uſe compiled this Treatiſe, never in the leaſt intending it ſhould have appeared in publick in this* nice *and* critical Age; *but it by chance falling into the hands of ſome of my* Mathematical Friends *and* Acquaintance, *I have at their requeſts condeſcended to publiſh it, though not without a great averſion in my own mind to expoſe my ſelf in any publick thing.*

But this difficulty being overcome, I ſhall give the Impartial Reader *to underſtand that I have faithfully compiled this* Treatiſe *from the beſt of* Authors (*and my own Experience*) *that I have contracted their various Works into this little* Cabinet *or choice* Compendium *of the* Mathematicks, *in which thou ſhalt find the whole Subject clearly and intelligibly handled: I have uſed a plain and eaſie method: I have laboured to*

be

be as plain and perſpicuous as poſſible: I have applied ſuch Examples to each as may beſt demonſtrate their Operation, be moſt eaſie for memory, and applicable to practice; here is indeed Multum in Parvo, *the whole* Marrow *of the* Mathematicks *is in this* Tract *afforded thee, which is as a true and* Golden Key *to unlock the choiceſt myſteries in thoſe Arts contained.*

Thus, Reader, *I have laid my labours before thee, and muſt intreat thee to uſe me as thou wouldſt be dove by, which is the* Spontaneous *act of every good man.*

But if this ſhall chance to fall into the hands of any curious conceited perſon, who thinks himſelf wiſer than the reſt of the world, and ſo he beginneth enviouſly to carp hereat, and like a Countrey Cur *bark at my backſide, to him I ſhall in modeſty onely ſay,* ------Facilius eſt unicuivis noſtrum aliena curiosè obſervare: quam propria negotia rectè agere. *'Tis much eaſier for thoſe* captious Readers *to carp than to copy.*

If the Collections *of* Authors *ſhall offend any, and ſo procure the ſame cenſure with the* Jackdaw, *as our learned Poet hath long ſince cautioned againſt* ------

Ne, ſi fortè ſuas repetitum venerit olim
Grex avium plumas, moveat cornicula riſum,
Furtivis nudata coloribus.

To the Reader.

I would have such contentious Readers *know that I have robbed no man of the honour of his Works, but have given to each his due; only I have borrowed some choice things of them, which is no more than what the most learned have always done.*

Thus, Courteous *and* Impartial Reader, *'tis only for thee that I have taken these pains, and have submitted to the publication hereof, and it is to thee the future parts of my study shall be serviceable, hoping that thou wilt find success in all thy Studies according to thy desire and endeavour; which are and shall be the hearty wishes of him who is*

Thine and *Urania's*

Servant,

London,
July 12,
1686.

John Taylor.

To the READER.

BEing desired to peruse this *Mathematical Treasury*, accordingly to gratifie the Request of my Friend I did, and I must confess with no small satisfaction to my self to see so much Practical Matter of usefull *Mathematical Arts* so neatly and compendiously digested into this Portable Volume; 'twill be usefull not only to *Learners* and meer *Tyro*'s, but to others also who have made some considerable progress in these Studies. 'Tis well *Methodiz'd*, very *Concise*, yet *Plain* and *Perspicuous*, so that any person of a pregnant fancy, may without a Tutour (in some reasonable time) wade through the whole, or any part thereof, and such as would be more expeditious may take the assistance of a Teacher to instruct them.

The Author is wholly a stranger to me, but to give him his due, in my opinion he has discharg'd himself like a Master in these Arts, and an Ingenious *Mathematician*, to whom I return thanks for this his generous offer in presenting his *Mathematical Treasury* to the Publick, and remain

October 25. 1686.

A true Lover of the Mathematical Sciences, and all such that really delight in those pleasing (but usefull) Speculations,

From my House in *Baldwin's Court* in *Baldwin's Gardens*, over against the Old Hole in the Wall.

Henry Coley.

Courteous Reader,

I Have perused this Treatise, and find that the Author has in every respect discharged himself like an *Artist*; the Work throughout the whole, is very plain and easie, nothing being omitted that might render it Intelligible to the meanest capacity: And indeed, I know not any Treatise of this nature extant that is more Practically handled, so that I doubt not but that it will be very serviceable to the Publick; and that thou in particular mayst find incouragement in the perusal thereof, is the hearty wish of him who is

Thine and Truths Servant,

John Hawkins, *Philomath.*

Octob. 30. 1686.
2 h. 40′ P.M.

To his learned and ingenious Friend Mr. *John Taylor*, in the deserved Praise of his Excellent Book intituled *Thesaurarium Mathematicæ*.

ATlas *and* Hercules *whom* Poets *feign*,
The heavy load of the Earth *to sustain*:
If so? great Toyl and Labour then they took,
Yet not so much as thou hast in thy Book.
Not like to them thy Labours, fictions are,
Thy works so true ingenious and so rare,
That seldom yet such works from man did flow,
For thou by them dost teach us all to know
The secrets of all Sciences and Art,
Which freely unto us thou dost impart.
Thou shew'st us how Numbers to understand,
And how the Speech of Numbers to command.
Geometry, *the Queen of truth, did cease*
The Egyptian *trouble, and did cause a peace;*
When proudly Nile *had overflown their ground,*
And all their Bounds and Land-marks did confound:
By it, each man his proper Right did gain,
And Peace by it great Egypt *did obtain.*
This Art so conspicuous thou hast made,
That to thy Glory it can never fade.
By Sines, Tangents *and* Secants *thou dost show*
Us all the parts of Triangles *to know.*
Thy lofty Genius *viewed the* Stars *on high,*
So that full well thou know'st Astronomy.

All

All motions of the Sun *and* Planets *thou*
Doſt underſtand, thy works do ſhew it now.
For thou ſuch Rules and Precepts doſt apply,
In this thy Book unto Aſtronomy;
Demonſtrated by rules ſo rare and plain,
That he's a Dunce *that can't it now obtain.*
Thus having view'd the Spheres *of* Heaven *well,*
Then on our Mother Earth thy Genius *fell.*
Thou view'ſt her round, ev'n by inſpecting all
The known parts of the Coſometick *Ball.*
And here in this thy Book thou let'ſt us ſee,
How Nations all moſt diſagreeing be.
The Seaman *he adores thee as his Friend,*
So liberal unto him thy Art doth lend;
And thou from him wilt not thy Talent hide,
Thy Book's a Light-houſe Mariners to guide.
Surveying *thou doſt teach and that ſo plain,*
That any one that Art may well obtain:
And by that means Injuſtice to disband,
Attending Lord *and Tenant of the Land.*
To thee the Brooks *and* Springs *do all ſubmit,*
And they will glide to that place thou think'ſt fit.
Thou ſhew'ſt Mechanick *well to apprehend,*
To meaſure Board *or* Glaſs, *nay as a Friend,*
Teacheſt them how both Timber *round and ſquare,*
And Stones *to meaſure of what kind ſo e're.*
Therefore to thee they praiſes ſtill will give,
And tho' thy Body's dead thy Fame ſhall live.
The Art of Gauging *thou doſt plainly teach,*
And farther far than worthy Oughtred *reach*
Into the Myſtery of that curious part,
And noble Branch of Mathematick Art.
Thou meaſureſt the courſe of times ſhort ſtay,
Thus Dials ſhew us how time flies away;

That

That thereby we may mind our fading breath,
And preparation make for certain death.
Thy Book's also prepar'd Mars *to withstand,*
In raising Forts *for to defend the Land.*
In ordering Armies *in* Battail aray,
And them Encamping *when they make a stay.*
The Gunner's Magazine *lies in this* Tract,
From whence directions he may have to sack,
Or storm a Town, or batter down a wall,
Or make a Breach *and at the joyfull fall*
Of Turrets *high* Huzza's *to make for joy,*
And entring in, his Enemies destroy.
These curious Arts with more than here are nam'd,
In this rich treasury so neatly fram'd,
Our friendly Authour doth to all impart,
Wishing success, and that with all his Heart.
But stop my Muse *let us not be so rude,*
We'll only wish him well and so conclude.
Maist thou, O Authour of this Treasury,
Reap to thy self profit and praise thereby;
And maist thou ever, ever happy be,
That we more of thy Learned works may see.
Live thou in splendid comfort to thy end,
So prays thy humble Servant, and thy Friend,

July 20.
1686.

Geo. Barrow.

To the Learned Authour my much respected Friend Mr. *John Taylor* on his *Herculean* labours in the Composure of this Excellent Mathematical Treasury.

I *ncrease our Muse, rouze up ye Sisters nine,*
O *n us bestow your Art that we may praise*
H *is works, his worth and his real design;*
N *ot honour vain, but skill aloft to raise.*
Vain Glory's to him but a trifling Toy,
'Tis Art alone, 'Tis that which is his Joy.

T *he Earth he hath trac'd, the Spheres of Heav'n* [*view'd*
A *nd Stars and Seas whose billows loud do roar;*
Y *et is he not nor can he be so rude,*
L *ike many others to lock up his store,*
O *h he doth not! his Treasure ope doth stand:*
R *eceive it as a Jewel from his Hand.*
Our noble Friend and Authour what's thy due?
Honour thou slight'st, Treasure's too vain for you.
Thy mind is fixt on Sciences above,
Thou art Urania's *favourite and love.*
Thou know'st her ways, her Art's at thy command,
She smiles upon thee, guides thee by the hand:
For which thy Name we will extoll and praise,
As far as Phœbus *sends his golden raies.*
Therefore in happiness let thy time run,
And rest in Peace when that thy Period's come.

Sept. 27. 1686.

Tho. Robinson.

An *Acroſtick* on the Name of my much reſpected and ingenious Friend Mr. *John Taylor*.

I *f Mathematicks be the Art to teach,*
O *by thy Book the Learned then may reach*
H *eavens Poles, and Circles without doubt or fear,*
N *or to find out each Star it's Hemiſphere.*

T *hough* Archimedes *hath much glory got*
A *mongſt the* Syracuſians, *why not,*
Y *ea Statues be erected to thy Name?*
L *et Eagles wings towre and ſoar thy fame.*
O *happy maiſt thou be, and this thy Book*
R *eaders inſtruct when e're they in it look.*

London, July 29. 1686.

Fran. Pierce.

ADVERTISEMENTS.

ALL Gentlemen, or other Perſons that ſhall have occaſion for any ſort of *Mathematical Inſtruments*, either for Sea or Land, may be furniſhed by *John Worgan*, *Mathematical Inſtrument-maker*, under St. *Dunſtan's Church* in *Fleet-ſtreet*, *London*.

At St. *George's Church* in *Southwark* are taught Writing, Arithmetick, Merchants Accounts, Geometry, Trigonometry, Aſtronomy, Navigation, Surveying, Dialling, Gauging and Gunnery, by *John Hawkins*, *Philomath*.

Arts and Sciences Mathematical, profess'd and taught by HENRY COLEY, Philomath. *at his House in* Baldwins Court *over against the* Old Hole *in the* Wall, *in* Baldwins Gardens *near* Grays-Inn-Lane.

ARITHMETICK in { Whole Numbers and Vulgar Fractions. Decimal, and by Logarithms.

GEOMETRY. { The Rudiments thereof, also the Demonstration and Practice, according to the best Authours.

ASTRONOMY. { The use of the Globes { Cœlestial, and Terrestrial. To project the Sphere in *Plano* to any Latitude several ways. To calculate the Longitude and Latitude of the Planets, with their Declination and Ascension. Also the true Time, Quantity, and Duration of *Eclipses* of the Luminaries for any time past or to come.

TRIGONOMETRY. { Or the Doctrine and Calculation of Triangles, both-- { Plain and Spherical. With the Application of the several Cases thereof in the most useful Questions in-- { Geometry. Astronomy. Geography. Navigation. Dyalling, *&c*

NAVIGATION. { In either of the three principal kinds of Sayling, *viz.* } by the { Plain and *Mercator's* Great Circle. } Chart

DYALLING. { Geometrically Instrumentally Arithmetically } by { The Sector, and other convenient Scales. [Tan. The Logarithms, Sines & }

SURVEYING. { Several ready ways to measure a Plat, and divide Land, *&c.* also the taking of Altitudes, Profundities, Distances, *&c.* together with the Mensuration of all manner of Superficies, as Boards, Glass and Pavement; also all Solids, *viz.* Timber, Stone, *&c.* Regular and Irregular.

GAGING. { To find the just quantity of Liquor in any Cask, whether full or partly empty. Also the content or solidity of Brewers Vessels, *&c.* Tuns, Coppers, Backs, Coolers, *&c.*

ASTROLOGY. { In all its parts, and according to the best Authors, with several varieties therein, not known to every Professor. *Non nobis nati sumus.*

The Contents.

CHAP. I.

Of Arithmetick Page 1.

CHAP. II.

The Explanation and Use of the Table of Logarithms. p. 18.

CHAP. III.

The Explanation of the Sines, Tangents and Secants. p. 28.

CHAP. IV.

Of Geometry. p. 32.

CHAP. V.

Of Trigonometry, or the Doctrine of Triangles. p. 59.

CHAP. VI.

Of Astronomy. p. 96.

CHAP. VII.

Of Geography, with a Geographical Description of the Earthly Globe. p. 122.

CHAP. VIII

Of Navigation. p. 186.

CHAP. IX.

Of Surveying. p. 214.

CHAP. X.

Of Measuring Boards, Glass, Tiling, Paving, Timber, Stones and Irregular Solids, such as Geometry can give no Rule for the Measuring thereof. p. 242.

CHAP. XI.

Of Gauging. p. 250.

CHAP. XII.

Of Dialling. p. 255.

CHAP. XIII.

Of Fortification, according to the modern and best ways now used by the Italian, Dutch, French *and* English Inginiers. p. 279.

CHAP. XIV.

Of Military Orders, or the Embattelling and Encamping of Soldiers. p. 301.

CHAP. XV.

Of Gunnery. p. 308.

A Table of Logarithms. p. 337.

A Table of Proportional Parts. p. 401.

A Table of Artificial Sines and Tangents. p. 417.

Arithmetick.

CHAP. I.

Of ARITHMETICK.

ARITHMETICK is an Art of numbring well; for as magnitude, or greatneſs, is the ſubject of *Geometry*, ſo is multitude, or number, that of *Arithmetick*.

Omnia quæcunque à primæva rerum natura conſtructa ſunt, Numerorum videntur ratione formata. Hoc enim fuit principale in animo conditoris exemplar. Boetius *Arith. lib. 1. cap. 2.*

I ſhall not in this place trouble you with the firſt Rudiments of Arithmetick, as Numeration, Addition, Subſtraction, Multiplication, and Diviſion: becauſe they are already largely handled by many, as Mr. *Leybourn*, Mr. *Wingate*, and divers others, and alſo that then this Book would ſwell to too big a bulk for the Pocket, and ſo my deſign would be fruſtrated; I ſhall therefore only propoſe and ope-

rate ſome principal Propoſitions, that are of Special moment in Arithmetick, and which moſt immediately concern the other following parts of this Treatiſe.

SECTION I.

§. 1. *The Explication of ſome Arithmetical Propoſitions.*

PROPOSITION I.

To three numbers given, to find a fourth in a Direct proportion.

To operate this proportion Multiply thē third term, by the ſecond term, and their product divide by the firſt term, the Quotient ſhall be a fourth term required. *Examp.* 1. Admit the Circumference of a Circle whoſe Diameter is 14 parts be 44 parts, what is the Circumference of that Circle, whoſe Diameter is 21 parts? Now according to the Rule if you multiply the third term 21, by the ſecond term 44, it produceth 924; which divided by the firſt Term 14, the Quotient is 66, and ſo the Circumference of the Circle, whoſe Diameter is 21, will be 66 parts, and ſo for any other in a direct proportion.

PROP.

§. 1.

PROP. II.

To three numbers given, to find a fourth in an Inverſed proportion.

To operate this proportion, Multiply the firſt term, by the ſecond term, and their product divide by the third term, the Quotient is the fourth term required: *Examp.* Admit that 100 Pioneers, be able in 12 hours to caſt a Mote of a certain length, breadth, and depth; in what time ſhall 60 Pioneers do the ſame? Now if according to the Rule, you Multiply the firſt term 100, by the ſecond term 12, their product is 1200; which divided by the third term 60, the Quotient is 20, ſo I ſay that in 20 hours, 60 Pioneers ſhall do the ſame, and ſo for any other in an Inverſed proportion.

PROP. III.

To three numbers given, to find out a fourth in a Duplicate proportion.

The nature of this propoſition is to diſcover the proportion of Lines, to Superficies, and Superficies, to Lines; for like Plains are in a duplicate Ratio; that is as the Quadret of their *Homologal* ſides; therefore to Operate any Example in this proportion, Square the third term, and its ſquare multiply by the ſecond Term, their product divide by the ſquare of the firſt Term, the Quotient is the 4th. term ſought; *Examp.* Admit there be two Geometrical ſquares; now if the ſide of the grea-

§. 1. ter square be 50 feet, and require 3000 Tiles to pave it; what number shall the lesser square require, whose side is 30 feet? To operate this according to the Rule, I square the third Term 30, whose square is 900: then I multiply it by the second Term 3000, its product is 2700000, which divided by 2500, the square of the first Term 50, the Quotient is 1080, and so many Tiles will pave the lesser square, whose side is 30 feet.

PROP. IV.

To three numbers given, to find a fourth in a Triplicate proportion.

THE nature of this proposition is to discover the proportion of Lines to Solids, and Solids to Lines; for like Solids, are in a Triplicate Ratio, that is to the Cubes, of their Homologal sides: Therefore to operate any Question in this proportion, Cube the third Term, and his Cube multiply by the second Term, and their product divide by the Cube of the first Term; the Quotient is the fourth Term sought. *Examp.* Admit an Iron Bullet whose diameter is 4 Inches, weigh 9 pounds; what is the weight of that Bullet whose Diameter is 6 Inches? Now to operate this proportion; first according to the Rule I Cube the third Term 6 whose Cube is 216, then I multiply its Cube by the second Term 9, the product is, 1944, which divided by 64, the Cube of the first Term; the Quotient is 30 $\frac{24}{64}$ pounds which is equal unto 30*l.* 6 ounces: which is the weight

of

of the propounded ſhot; and ſo for any other. §. 1.

PROP. V.

To two numbers given, to find out a third, fourth, fifth, ſixth, &c. Numbers in a continual proportion.

To operate this proportion, you muſt multiply the ſecond number by it ſelf, and that product divide by the firſt Term, the Quotient is a third proportional: Again you muſt multiply the third Term by it ſelf, and its Quadret divide by the ſecond Term, the Quotient is a fourth proportional, and ſo after this manner a fifth, ſixth; or as many more proportionals as you pleaſe may be found: *Examp.* Let it be required to find ſix numbers in a continual proportion to one another; as 4 to 8. To operate this firſt according to the Rule, I multiply the ſecond Term 8 by it ſelf the product is 64, which divided by the firſt Term 4, the Quotient is 16: ſo is 4, 8, and 16 in a continual proportion; And ſo obſerving the Rules preſcribed, proceed in your operation untill you have found your ſix numbers in a continual proportion; which in this Example will be 4, 8, 16, 32, 64, and 128, and ſo will you have form'd ſix numbers in a continual proportion.

§. 1.

PROP. VI.

Between two numbers given, to find out a mean Arithmetical proportional.

THIS propoſition might be performed without the help of the rule of proportion: nevertheleſs becauſe it conduceth to the Reſolution of the next enſuing propoſition, I inſert it in this place; To operate it this is the Rule: add half the difference of the given Terms, to the leſſer Term, ſo that Agragate, is the Arithmetical mean required: *Examp.* Admit 20 and 50 to be the two numbers propounded: Now to operate this propoſition, firſt according to the Rule, I find that the difference of the two given Terms 20, and 50, is 30, whoſe half is 15, which being added to the leſſer Term 20, it makes 35, ſo is 35, a mean Arithmetical proportion betwixt 20, and 50, given.

PROP. VII.

Between two numbers given, to find out a mean Muſical Proportional.

BOETIUS hath this Rule for it, wherefore take his own words: * ſaith he, "*Differentiam terminorum in minorem terminum multiplica, & poſt junge terminos, & juxta cum qui inde confectus eſt; committe illum numerum, qui*

* *In his ſecond Book of his Arithmetick, and the 38 Chapter, where he ſaith that this proportion hath,* Magnam vim in Muſici modulaminis tempera-

" *qui ex differentiis & ter-*
" *mino minore productus*
" *eſt, cujus cum latitudi-*
" *nem inveneris, addas*
" *eam minori termino, &*
" *quod inde colligitur me-*
" *dium terminum pones.* That is, Multiply the difference of the Terms, by the leſſer term, and add likewiſe the ſame Terms together: this done if you divide the product, by the ſum of the Terms, and to the Quotient thereof, add the leſſer Term; the laſt Sum is the Muſical mean deſired: *Examp.* Admit the two numbers given be 6, and 12. I ſay that if the difference of the Terms which is 6, were Multiplied by the leſſer Term 6, it would produce 36: then if you add the two terms 6, and 12, together: their ſum would be 18, now if you divide 36, by 18, the Quotient is 2; laſtly if to the Quotient 2, you add the leſſer Term 6, the ſum thereof will be 8, which is a Mean Muſical proportional required.

mentis, & in Speculatione naturalium queſtionum: *i. e. Great force in Muſical compoſition, (or in the Compoſure of Muſick) and in the diſcovery of the Secrets of Nature.* §. 1

PROP. VIII.

How to find the Square-Root of any whole number, or Fraction.

Defin. To Extract the Root of any Square number propounded, is to find out another number, which being Multiplied by it ſelf, produceth the Number propounded. Now for the more eaſie and ready Extraction of the Square-Root of any number given, This Table

§. 1. here under annexed will be uſefull; which at firſt ſight giveth all ſingle Square numbers, with their reſpective Roots.

ROOT.	1	2	3	4	5	6	7	8	9
SQUAR.	1	4	9	16	25	36	49	64	81

The Explication of the Table.

In the uppermoſt rank of this Table, is placed the reſpective root of every ſingle Square-number, and in the other the ſingle Square-numbers themſelves; ſo that if the Root of 25 were demanded, the Anſwer would be 5, ſo the Square-root of 49, is 7, of 81 is 9; and ſo for the Reſt, and ſo contrarily the Square of the Root 5 is 25, of 7 is 49, of 9 is 81, *&c.*

Example: If the Square-root of 20736, were required, firſt they being wrote down in order as you ſee, draw the Crooked-line, * then to prepare this or any other number for Extraction, make a point over the place of *Unites*; and ſo on every other figure towards the Left-hand, as you ſee in the Margent. Then

* *As you uſe to doe in Diviſion to repreſent the Quotient.*

§. 1.

Then find the Root of the first Square 2, which is 1; place it in the Quotient, and also under 2; then draw a line, and substract 1 from 2, there remains 1; which place under the line, then to the last remainder 1, bring down the next Square 07; and then there will be this number 107, which number I call a Resolvend: Then double the Root in the Quotient 1, whose double is 2, which 2 place under the place of tens in the Resolvend, under 0; so is this 2 called a Divisor; and 10 called a Dividend.

```
 .   .   .
2 0 7 3 6 (1 4 4
1
-----------
1 0 7
  2 4
  9 6
-----------
1 1 3 6
  2 8 4
1 1 3 6
-----------
    0 0
-----------
```

Then demand how often the Divisor 2, can be had in the Dividend 10, it permitteth but of 4, which place in the Quotient, and under 7 the place of *Unites* in the Resolvend, and there will appear this number 24; Then Multiply this 24, by 4, (the last Square placed in the Quotient) it produceth 96, which place orderly under 24, as you see, and this 96 is called a *Ablatitium*; (but some calleth it a *Gnomon*:) then draw a line under it, and substract 96, the *Ablatitium*, out of the Resolvend 107, there remains 11, which place orderly under the last drawn line, then thereunto bring down the next Square 36, so will there be a new Resolvend 1136; then double the whole Root 14 in the Quotient, whose double is 28;

place

§. 1. place it under the Reſolvend 1136 as was afore directed; ſo ſhall 28 be a new Diviſor, and 113 be a Dividend; then I find the Diviſor 28 can be had in the Dividend 113, 4 times, which four place in the Quotient, and under the place of *Unites* in the Reſolvend, ſo there appeareth this number 284, which number, multiplyed by 4, the laſt figure in the Quotient, produceth a new *Ablatitium* 1136; which place orderly under the Reſolvend 1136, and then draw a line, then ſubſtract the *Ablatitium* 1136, from the Reſolvend 1136; and the remainder is 00, or nothing: and thus the work of Extraction being finiſhed, I find the Root of the Square number 20736, to be 144; and ſo muſt you have proceeded gradually ſtep by ſtep, if the number propounded, had conſiſted of ſome 4, 5, 6, or more Squares; ſtill obſerving the aforegoing Rules and Directions.

NOTE.

BUT when a whole number, hath not a Root exactly expreſſible by any rational or true Number, then to find the fractional part of the Root very near; To the given whole number annex pairs of Cyphers, as 00, 0000, or 000000, then eſteem the whole number, with the Cyphers both annexed thereunto, as one intire whole number: and Extract the Root thereof according to the foregoing Directions, then as many points as were placed over the Integers, ſo many of the firſt figures in the Quotient muſt be taken for Integers; and the remainder for the Roots fractional part in Decimal

cimal parts, and ſo you may proceed infinitely near the true Root of a Number. §. 1.

To Extract the Square-Root of a Vulgar or Decimal Fraction, and a Mixt-number.

First if the Fraction propounded be not in its leaſt Terms, reduce it, and then by the Rules aforegoing, find the Root of the Numerator for a new Numerator; and of the Denominator for a new Denominator; ſo ſhall this new Fraction be the Square-root of the Vulgar Fraction propounded, ſo the Square-root of $\frac{16}{25}$ is $\frac{4}{5}$.

The manner of Extracting the Square-root of a Decimal Fraction.

But many times the Numerator and Denominator of a Vulgar Fraction hath not a perfect Square-root; to find whoſe Root infinitely near, you muſt reduce it into a Decimal Fraction, whoſe Numerator muſt conſiſt of an equal number of places, to wit, 2, 4, 6, *&c.* Then Extract the Square-root of that Decimal, as if it were a whole number, and the Root that proceedeth from it is a Decimal Fraction, expreſſing the Square-root of the Fraction propoſed, infinitely near: ſo the Root of $\frac{13}{16}$ (whoſe Decimal is, 81250000) will be found to be 9013 which is very near, for it wanteth but $\frac{1}{10000}$ of an Unite of the exact Square-root, of $\frac{13}{16}$ propounded.

The manner of Extracting the Square root of a Mixt-Number.

Now having a Mixt Number propounded whoſe Root is required, to find which reduce it into an improper Fraction, and then Extract the

Root

§. 1. Root thereof as before. Suppose the Number propounded be $75\frac{24}{54}$; its improper Fraction is $\frac{679}{9}$, whose Square-root I find to be $\frac{26}{3}$. or $8\frac{2}{3}$, very near, *&c.* But if it had not an Exact Square-root, then reduce the Fractional part of the given Mixt-number into a Decimal Fraction, of an even number of places, and then annex this Decimal to the Integers, and so Extract the same, as a whole number; and observe that so many points as were set over the Integers, so many of the first figures in the Quotient must be esteemed Integers; and the Remainder for the Roots Fractional part.

PROP. IX.

How to find the Cube-Root of any whole Number, or Fraction.

Defin. To Extract the *Cube-Root* of any Number propounded, is to find out another Number, which being multiplied by it self, and that product by the number again, shall produce the number propounded; Now for the more easie and ready Extraction of the Cube-root of any number propounded, this Table hereafter annexed will be usefull, which at first sight giveth the Cube root of any whole number under 1000; which are called single Cube-numbers.

ROOT.

§. 1.

ROOT.	1	2	3	4	5	6	7	8	9
CUBE.	1	8	27	64	125	216	343	512	729

The Explication of the Table.

In the uppermoſt rank of the Table is placed the reſpective Roots of every ſingle Cube, and in the other the reſpective ſingle Cube-Numbers; for if the Cube-root of 512 were deſired, the Anſwer would be 8, of 64 is 4; and ſo of the reſt: and if the Cube of the Root 7 were deſired, it would be found 343; of 9 it would be 729, *&c.*

Examp. Admit the Cube root of the Number 262144, were required, firſt they being wrote down in order as you ſee, draw the Crooked-line.

Then place a point over the place of Unites, and another over the place of Thouſands; and ſo on ſtill intermitting two places between every adjacent point; and obſerve that as many points, as in that order are placed over any number propounded, of ſo many figures doth the Root conſiſt

* *As you uſe to do in Diviſion, to repreſent the Quotient.*

§. 1.

```
  .   .
2 6 2 1 4 4 (6 4
2 1 6
-------------
  4 6 1 4 4
  -------------
  1 0 8
      1 8
  -------------
  1 0 9 8
  -------------
  4 3 2
    2 8 8
        6 4
  -------------
  4 6 1 4 4
  -------------
        0 0
  -------------
```

consist of: so that in this Example, there being two points, therefore the Root consisteth of two places as you see in the Quotient; Now first find the Root of the first Cube 262; which permitteth but of 6, place 6 in the Quotient, and subscribe its Cube 216, under 262, and then draw a line under it, and substract 216, out of 262, and the remainder is 46, which place in order under the last drawn line as you see. Then to the Remainder 46, bring down the next Cube-number 144, so will there appear 46144, which I call a Resolvend: then draw a Line under it, and square the Number in the Quotient 6, whose square is 36; Then Triple it and it will be 108, Then subscribe this Triple square 108, under the Resolvend, so that the place of Unites in the Triple Square 8, may stand under 1 the place of Hundreds in the Resolvend: Then Triple the Root in the Quotient 6, whose Triple is 18, Then subscribe the Triple 18, under the Resolvend, so that the place of Unites 8 in the Triple, may stand under 4 the place of Tens in the Resolvend, and so draw a Line underneath it, and add the Triple Square 108, and the Triple 18 together in such order as they

stand

ſtand, their Sum is 1098, which may be called a Diviſor, and the whole Reſolvend 46144, except 4 the place of Unites a Dividend; then draw another line. §. 1.

Then ſeek how many times 1098 the Diviſor, can be had in 4614 the Dividend, it permitteth but of 4, which ſubſcribe in the Quotient; Now Multiply the Triple ſquare 108, by 4, it produceth 432, which in order ſubſcribe under the Triple ſquare 108: Then ſquare 4, the figure laſt placed in the Quotient, whoſe ſquare is 16; and Multiply it by 18 the Triple, it produceth 288, which ſubſcribe under the Triple orderly, then ſubſcribe the Cube of 4 (laſt placed in the Quotient) which is 64, in Order under the Reſolvend. Then draw a line underneath it, then add the three numbers, *viz.* 432, 288, and 64, together in ſuch order as they are placed, their ſum is 46144: Then draw another line under the Work, ſubtracting the ſaid total 46144, from the Reſolvend 46144, there remains 00, or nothing, which remainder ſubſcribe under the laſt drawn line, thus the work being finiſhed I find the Cube root of 262144 the number propounded, to be 64: And thus you muſt have proceeded orderly ſtep by ſtep, if the number propounded had ariſen to ſome 3, 4, 8, 10, or more places, obſerving the direction preſcribed untill all had been compleated.

NOTE.

BUT when a whole number, hath not a Cube-root expreſſible by any true or Rational number,

§. 1. number, then to proceed infinitely near the Exact truth annex to the number Tenaries of Cyphers as 000, 000000, 000000000, *&c.* then esteeming the whole number with the Cyphers annexed as one intire whole Number, Extract the root thereof, as is afore taught. Then as many points as were placed over the Whole Number, so many places of Integers will there be in the Root, and the rest expresseth the Root his Fractional part very near.

To Extract the Cube-Root, of any Vulgar or Decimal or Mixt Fraction consisting of a Whole Number and a Fraction.

To Extract the Cube-root of any Vulgar Fraction, you must first reduce it into his least terms, and then according to the former directions Extract the Cube-root of the Numerator, the Root found shall be a new Numerator; so likewise the Root of the Denominator shall become a new Denominator; so shall this new Fraction be the Cube-root of the Fraction propounded, so I find the Cube-root of $\frac{8}{125}$ to be $\frac{2}{5}$, and so for any other Vulgar Fraction.

The manner of Extracting the Cube-Root of a Decimal Fraction.

But many times the Numerator, and Denominator, hath not a true Root: Then to find the Root thereof infinitely near, you must reduce the Fraction given, into a Decimal, whose numerator is Tenaries of places, and then Extract the Root according to the former Directions, so shall the Root found, be a Decimal Fraction expressing near the Cube-root of the Fraction

Fraction propounded, so I find the Root of $\frac{8}{12}$ or $\frac{2}{3}$, whose Decimal is, 666666666, to be, $\frac{873}{1000}$ very near the Root of $\frac{8}{12}$ or $\frac{2}{3}$ propounded. §. 1.

The manner of Extracting the Cube-Root of a Mixt-number.

Now having a Mixt-number propounded, whose Root is required, first reduce it into an Improper Fraction, and then Extract the Cube-root thereof, as is afore directed, so the Cube-root of $12\frac{19}{27}$, Improper $\frac{343}{27}$, will be found to be $\frac{7}{3}$ or $2\frac{1}{3}$.

But if it hath not an Exact Cube root, Then Reduce the Fractional part of the given Mixt-number into a Decimal Fraction, which shall consist of Tenaries of places, Then to the whole number annex the Decimal Fraction, and Extract the Cube-root of the Whole, and observe that so many points as are over the Integers, so many of the first places in the Quotient must be Esteemed Integers, and the rest Expresseth the Fractional part of the Root in Decimal parts of a Fraction, so the Cube-root of $2\frac{3}{8}$, Decimal 2, 375000000 *&c.* will be found to be 1, 334, or $1\frac{334}{1000}$, and is very near the true Root, and so for any other Mixt-number of this nature.

CHAP. II.

The Explication, and use of the Tables of LOGARITHMS.

§. 1.

SECT. I.

The Explication of the Tables of the Logarithms, and of parts proportional.

Defin. THE *Logarithms*, were first invented, found out and framed, by that never to be forgotten and thrice Honourable Lord, the Lord *Nepeir*: which Numbers, so found out and framed by his diligent industry, he was pleased to call *Logarithms*; which in the Greek signifies the Speech of Numbers, I shall not here trouble you with the manner of the Construction of those Tables of *Logarithms* but shall first lay down some brief and general Rules, that thereby the better you may Understand those Tables, and then I shall explain their manifold uses, in sundry Examples Arithmetical, *&c.*

PRO

PROP. I.

Any Number given under 10000, *or* 100000, *to find the Logarithm correſponding thereunto.*

§. 1. 1. If the number propounded conſiſt of one place whoſe Logarithm is required to be found, as ſuppoſe (5,) look for 5, in the top of the left hand Column under the Letter * *N*, and right againſt 5, and in the next Column under *LOG.* * you will find this number or rank of figures, 0698970, which is the Logarithm of the number 5 required.

* *Signifies the Number, or figure ſought.*
* *Signifies the Logarithm anſwering to the number Oppoſite.*

2. If the number conſiſteth of two places as if it were 57, look 57 under *N*, and oppoſite to it and under *LOG.* you will find this number 1. 755875, which is the Logarithm of 57, the number propounded.

3. If the number propounded conſiſt of three places as 972, look for 972, under *N*, and oppoſite to 972, and under o) the Column, you ſhall find this number 2. 987666, which is the Logarithm of 972, the number which was propounded.

4. But if the number conſiſt of four places as 1685, look the three firſt figures 168, under the Column *N*, and oppoſite to that, and under 5 at the top of the page, you will find this number 3. 226599, which is the Logarithm of 1685, the number propounded.

§. 1. ☞ *Note this Rule well, for this explains the uſe of the Table of proportional parts, printed at the end of this Book.*

5. But if the number given be above 10000, and under 100000, you may find its Logarithm by the Table of parts proportional, printed at the latter end of this Book. Thus if the Logarithm of 35786, be ſought, firſt ſeek the Log. of 3578, which will be 553649, and the common Difference under D is 121; with this difference 121, Enter the Table of parts proportional, and finding 121 in the firſt Column under D, you may then lineally under 6, find the number 72, which add to the Log. of 3578, that is 553649, it produceth, 553712, which is the Log. of 35786 the number propounded: now becauſe the number propounded 35786, ariſeth to the place of *X. M.* therefore there muſt be the figure 4 prefixed before its Logarithm, and then it will be thus 4, 553712, which 4, is called the Index, as ſhall be hereafter ſhewed.

Now before we proceed to find numbers correſponding to Logarithms, it will be neceſſary to explain the meaning of the firſt figure to the left hand of any Logarithm placed, Mr. *Briggs* calleth it a Characteriſtick or Index, which doth repreſent the diſtance of any the firſt figure of any whole number from Unity, whoſe Index is 0, a Cypher; ſo the Index of 10 is 1, and ſo to 100 whoſe Index is 2, and ſo to 1000 whoſe Index is 3, and ſo to 10000 whoſe Index is 4, and ſo if you perſiſt further the Characteriſtick is always one leſs in dignity than

Definition. *The Rule to find the Characteriſtick or Index appertaining to any Logarithm.*

than the places or figures of the number propounded. §. 1.

PROP. II.

To find the Logarithm belonging to a Vulgar Fraction, and a Mixt number.

Firſt as is before ſhewed if it be a Vulgar Fraction, find the Log. of the Numerator, and the Log: of the Denominator, then ſubſtract the Log: of the Numerator, from the Log: of the Denominator, the remainder is the Log: of the Fraction propounded: Now if you would find the Logarithm of $\frac{5}{7}$, do as is preſcribed whoſe Log. I find to be 0. 146121, Now to find the Log. of a Mixt Number, reduce it into an Improper Fraction, and then do as before, ſo the Log of $15\frac{2}{3}$, Improper $\frac{47}{3}$, is 1,187,52, and ſo do for any other Mixt number.

The Log: 7 is ——— 0. 84509
The Log: 5 is ——— 0. 69897
The Log: $\frac{5}{7}$ is ——— 0. 14612

PROP III.

A Logarithm propounded to find the whole, or Mixt number, correſponding thereunto.

For the more ſpeedy finding the number, anſwering unto the Logarithm propounded, obſerve that if the Index be 0, then the Number ſought may be found between 1 and 10; If 1,

§. 1. between 10 and 100; if 2, between 100, and 1000; if 3 between 1000 and 10000, and so on still observing the Rules of the Characteristick, or Index, therefore look in the Table untill you find the Logarithm proposed, and against it in the Margent according to the aforegoing directions under *N*, you shall find the number belonging thereunto. This Rule holds in force in Mixt Numbers also.

Thus.	0. 845098	Are the Logarithms of,	7
	1. 556302		36
	2. 130334		135
	3. 980276		9556

NOTE.

But if you cannot find the Logarithm exactly in the Table, as in many operations it so hapneth, you must then take the neareſt Logarithm Number to the Logarithm propounded, and so take the number belonging thereto for the desired number.

SECT.

SECT. II. §. 2.

Of the Admirable uſe of the Logarithms in Arithmetick.

PROP. I.

To Multiply one number by another.

Admit 90, be to be multiplied by 42, what is the product? To find which firſt find the Log. of the Multiplicand 90, whoſe Log. is 1.95424: Then

find the Log. of	The Log: of 90 is—	1. 95424
the Multiplier	The Log: of 42 is—	1. 62324
42, whoſe Log:		
is 1 62324, then	The Log: 3780 is—	3. 57748
add theſe two		

Log: together, *viz.* the Log: of the Multiplicand, and Multiplier, their ſum is 3, 57748, which is the Log: of 3780, the product of 90; and 42, Multiplied together.

PROP. II.

To Divide one number by another.

Admit the Dividend (or number to be divided) be 648, and the Diviſor 72, what is the number that the Quotient ſhall conſiſt off? To find which, firſt write down the Logarithm of the Dividend 648, which is 2. 81157 and al-

§. 2. ſo write down the Logarithm of the Diviſor 72, which is 1. 85733. Now ſubſtract the Log: of the Diviſor, out of the Log: of the Dividend,

The Log: of 648 is	2. 81157
The Log: of 72 is	1. 85733
The Log: of 9 is	0. 95424

the remainder is 0. 95424, which is the Logarithm of 9, ſo I conclude that the Diviſor 72, is contained in the Dividend 648, 9 times, and ſo do for any other.

PROP. III.

To find the Square-Root of a Number.

Admit it be required to Extract the Square-Root of the Number 144, to perform which firſt write down the Log: of 144 which is 2. 15836. Then take the half thereof which is 1. 07918 which number 1. 07918, is the Log: of 12, the Root of 144 propounded, and ſo do for any other.

NOTE.

Now on the Contrary by doubling the Log. of any number, you have the Geometrical Square thereof.

PROP.

§. 2.

PROP. IV.

To find the Cube Root of any Number.

Admit it be required to Extract the Cube Root of 1728, to perform which, Firſt write down the Log. of 1728 which is 3. 23754, then take the third part thereof which is 1. 07918, which is the Log. of 12; which is the Cube-root of the Number propounded 1728, and ſo for any other. Note on the contrary if you multiply the Log. of any Number propounded by 3, it produceth the Log. of the Cube thereof.

PROP. V.

A Summ of Money being forborn for any number of years, to find how much it will amount unto, reckoning Intereſt on Intereſt, according to any Rate propounded.

Admit 300 pounds Sterling, be put out for 4 years, for Compound Intereſt at 6 *l.* per Cent. what will it amount to when the four years are expired? To find which ſubſtract the Log of 300 *l.* the principal, whoſe Log. is 2. 477121, out of the Log. of 318 *l.* Principal and Intereſt for a year whoſe Log. is 2. 502427, the remainder is 0. 025306, which being multiplyed by 4, the number of years of its continuance, produceth 0. 101224, which added to the Log. of the principal 300*l.* to wit, to 2. 477121, makes 2, 578345, which is the Log. of 378 *l.* 14 *s.* 10*d.* 2*q.* very near, and ſo much will 300 *l.* amount to.

PROP.

PROP. VI.

A Summ of Money being to be paid hereafter, to find what it is worth in ready Money.

§. 2. Admit 100 pounds Sterling, to be paid at 30 years end; I demand how much it is worth in ready Money? after the rate of Intereſt of 6 *l. per Cent.* To find which ſubſtract the Logarithm of 100 the principal, whoſe Log. is 2.000000 from the Log. of 106 Principal and Intereſt, whoſe Log. is 2. 025306, the remainder is 0 025306, which Multiplyed by 30 the number of years to ſucceed, produceth 0. 759180, which ſubſtracted out of 2. 000000, leaveth 1.240820, which is the Log. of 17 $\frac{411}{1000}$, which ſheweth the ſaid 100 *l.* is worth but 17 *l.* 8*s.* 2*d* 3*q. fere.*

PROP. VII.

A yearly rent, or Annuity to continue any number of years, to find what it is worth in ready Money, at any Rate of Intereſt propounded.

What is 100 pound *per annum* to continue 30 years, worth in ready money at 6 *l. per Cent.* To find which firſt ſubſtract the Log of 100 *l.* the principal, which is 2. 000000 from the Log. of 106 *l* principal and intereſt for a year, whoſe Log. is 2. 025306 the remainder is 0. 025306: Then Multiply 0. 025306, by 30 the number of years of its continuance, it produceth the number 0. 759180; Then Divide 100 *l.* by 6 the

the rate of intereſt and the Quotient is 16 $\frac{6667}{10000}$, §. 2.
&c. which: 16 $\frac{6667}{10000}$, is the proportional parts of 100 *l.* the principal, then add the Log. thereof which is 1. 221829 to the former Log. 0. 759180 it produceth 1.981009, which is the Log. of 95 $\frac{7215}{10000}$ parts the Arrearages with the ſaid ſome for that Time, then from thoſe Arrearages 95 $\frac{7215}{10000}$, ſubſtract the parts proportional of 100, to wit 16 $\frac{6667}{10000}$, the remainder is 79 $\frac{0548}{10000}$, which is the bare Arrearages for that proportional part; Then take the Log. of 79 $\frac{0548}{10000}$, which is 1. 897929, out of the which take the Log. found by Multiplication of years, to wit 0. 759180, there remains 1. 138749, which is the Log. of the value of the Arrearages in ready money, Then to the Log. 1. 138749, add the Log. of 100 *l.* principal, 2. 000000, it produceth this number 3. 138749; the Log. of 137 6-$\frac{48}{100}$, reduced is 1376 *l.* 9. *ſh.* 7*d.* $\frac{80}{100}$ or $\frac{4}{5}$ *fere*: and ſo much is the ſaid Annuity worth in ready money.

CHAP.

CHAP. III.

The Explication of the SINES, TANGENTS, *and* SECANTS.

SECT. I.

Of Right Signs, Tangents, Secants, Cosines, Tangents, and Secants: Of any Arch, or Angle of a Triangle.

PROP. I.

To find the right Sine, or Tangent of any Arch or Angle of a Triangle containing any number of Degrees and Minutes.

§. 1. ☞ *And here'tis necessary to understand, that every Circle is supposed to be divided into* 360 E-

IF the Angle or Arch of the Triangle propounded be less than 45 Deg. the Sine, or

or Tangent belonging thereunto, is found in the Column under the Title SINE, or TANGENT, at the top of the Table; and if there be any Minutes annexed unto the Degrees, you must find them out in the first Column under M. signifying Minutes, and opposite to those Minutes, and under the title aforesaid, you shall have the Logarithm of the Sine or Tangent, of the Arch or Angle required.

§. 1.

qual parts which are called Degrees, and every of those Degrees into 60 Minutes, and every Minute into 60 Seconds, and every Second into 60 Thirds, &c. so that a Semi-Circle contains 180 Degrees, and a Quadrant 90 Degrees; Now an Arch or Angle of a Triangle, is the Intersection of its two sides, and the measure thereof, is an Arch of a Circle, which cutteth each of the two sides equidistant from the Angular point, (which is the Center.) Now the Logarithm Sine, or Tang. of any such Arch of a Triangle, containing any Number of Degrees or Minutes of the Quadrant, may be found in the Tables, printed at the End of this Book, where they are plainly expressed, and are found as directed in the precedent Rules.

But if the Arch or Angle of a Triangle exceed 45 Degrees, you must then look for the Sine or Tangent belonging thereunto, in the bottom of the said Table, and if thereunto are Minutes annexed, you must look for them in the first Column to the Right hand under M. and so opposite to those Minutes in the Column above the Title, Sine, or Tang; there have you the Log. of the Sine, or Tangent, of the Arch or Angle, of the Triangle propounded.

Exemp.

§. 1. *Exampl.* Suppoſe it were required to find the Log-Sine or Log-Tangent; of an Angle of 25 D. 37 M. whoſe Log Sine, whereof according to the former directions I find to be 9. 635833. and Tangent thereof to be 9. 680768. and ſo for any other under 45 degrees.

Again, ſuppoſe it were required to find the Log-Sine or Log-Tangent, of an Angle of 64 D. 23 M. the Sine whereof, I find to be this number 9, 955065, and the Tangent thereof, 10. 319231, and ſo for any other Arch, or Angle of a Triangle, above 45 degrees.

PROP. II.

To find the Co-Sine or Co-Tangent of any Arch, or Angle propounded.

Defin. The Co ſine or Co tangent, of an Angle or Arch, is the remaining part of the Angle propounded, to a Quadrent or 90 Degrees; and is by ſome called the Complement of an Angle, thus the Arch or Angle of 64 D. 23 M. taken out of 90 D. leaves 25 D. 27 M. for its Complement, on the contrary if 25 D. 37 M. were taken out of 90 Degrees, there would remain 64 D. 23 M. for its Complement. So you ſee that theſe two Angles, are the Complements of each other, becauſe they two are equal to a Quadrent or 90 Degrees.

Now the Logarithm of the Complement, may be exactly found with eaſe, for the Sines and Tangents of every degree, and Minute of the Quadrent in one Column is joyned with his Complement in the next Column, ſo that with-

without ſubſtracting the Angle from 90 D. you may readily find the Complement thereof either the Arch in Degrees and Minutes, or the Log. Sine, or Tangent thereof, as you have occaſion: Thus the Log. of the Sines Complement before mentioned, to wit, 64 D. 23 M. Comp. is 25 D. 37 M. is 9. 635833, Tang. is 9. 680768; ſo 64 D. 23 M. is the others Compl. whoſe Sine is 9. 955065, and his Tang. is 10, 319231; ſo for any other. §. 1.

PROP. III.

To find the Secant of any Arch or Angle propounded.

In this little Book I have not room to ſet down the Tables of Artificial Secants at large, as I have done with the Sines and Tangents: Nevertheleſs I will not here omit to ſhew how they may be eaſily found out, by the Tables of Sines. The method is thus, ſubſtract the Logarithm Sine, of the Sines compl of an Ang'e, from the double *Radius* of the Tables, and the remainder ſhall be the Secant required: As if I deſire the Secant of 25 D. 37 M. I find the Logarithm ſine of his complement to be 9. 955065, which ſubſtracted from the double *Radius*, that is 20 000000; there remains 10, 044935 which is the Secant of it, and ſo the Secant of 64 D. 23 M. is 9. 955065; which is the Complement of the former, becauſe they both are Equal to 20. 000000, the double *Radius*; and ſo may any other be found out.

CHAP.

CHAP. IV.

Of GEOMETRY.

Defin. THE End and Scope of Geometry is to measure well: for as Number or Multitude, is the Subject of Arithmetick: so is Magnitude that of Geometry: to measure well is therefore to consider the Nature of every thing that is to be measured; to compare such like things one with another: and to understand their Reason and proportion, and also their similitude: And this is the End and Scope of Geometry *.

* *Quod quæritur cognoscendi illius gratia, quod semper est, non & ejus quod oritur, quandoque & interit. Geometria, ejus quod est semper, Cognitio est. Ac tollet igitur (ô Generose vir) ad veritatem, animum: atque ita, ad Philosophandum preparavit cogitationem, ut ad supera convertamus: quæ nunc, contra quàm decet, ad inferiora dejicimus, &c.* Plato *lib.* 7. *de Rep.*

I shall not trouble you with the Definitions of Geometry, they being largely handled by many, and herein every one meanly conversant in the study of the Mathematicks is acquainted,

quainted, but ſhall immediately fall in hand with the principal Propoſitions, which chiefly concern the other following parts of this treatiſe.

SECT. I.

§. 1.

The Explication of ſome Geometrical Propoſitions.

PROP. I.

To erect a perpendicular on any part of a line aſſigned.

LET the Line be A, B, and on the point D, 'tis required to raiſe a *perpendicular* to A, B, To operate which firſt open your Compaſſes to any convenient diſtance, and placing one foot thereof in D, with the other make the two marks C, and E, equidiſtant from D; then open the Compaſſes to ſome other convenient diſtance, and ſet one foot in E, and deſcribe the *Arch* F F; then likewiſe in C, deſcribe the *Arch* G G, then through the Interſections of theſe two *Arches*, and to the point D, draw H D, *perpendicular* to A B; as was required. *Fig.* 1.

PROP. II.

To Erect a Perpendicular, on the End of a Line.

Let the given line be A B, and on the End thereof at B, 'tis required to raiſe a *Perpendicular* *Fig.* 2.

§. 1. dicular line: To perform which open your Compaſſes to the diſtance B D, then on B as a Center, deſcribe the Arch D, E, F, then from D, to E, place B D; then placing one foot in
Fig. 2. E, deſcribe the Arch C F, then remove your Compaſſes to F, and draw the Arch C E; Laſtly through their Interſection draw C B, which is a *Perpendicular* to AB, on the end B; as required.

PROP. III.

From a Point above to let fall a Perpendicular on a Line.

Fig. 3. Let the line given be B A, and 'tis required from the point above at C; to let fall a *Perpendicular* to the ſaid Line: To perform which place one foot of your Compaſſes in C, and open them beyond the given line A B, and deſcribe the Arch EF; divide EF, into two parts in D; Laſtly draw C D, which ſhall be perpendicular unto AB, falling from the point above at C, as was ſo required.

PROP. IV.

To draw a right line Parallel to a right line, at any diſtance aſſigned.

Fig. 4. Let the diſtance aſſigned be O E, and the Line given be A B, and 'tis required to draw C D, *Parallel* to A B; at the diſtance O E: To perform which, take in your Compaſſes the diſtance O E, and on A, deſcribe the

the *Arch* H, and on B, the *Arch* K; then draw C D, ſo as it may juſtly touch the two *Arches*, but cut them not, ſo ſhall C D; be parallel to A B, at the aſſigned diſtance O E, as was required. §. 1.

PROP. V.

To Protract an Angle of any Quantity of Degrees propounded.

Let it be required to *Protract*, or lay down an *Angle*, of 40 degrees: To perform which firſt draw a right line as A B, then open your Compaſſes to 60 degrees, in your line of *Chords*: and with that Diſtance on A, deſcribe the *Arch* E F, then take 40 degrees in your Compaſſes out of your line of *Chords*, and place it on the *Arch*, from F, to H; Laſtly through the point H, and from A draw A C; ſo ſhall the *Angle* CAB contain 40 degrees as required. *Fig.* 5.

PROP. VI.

To meaſure an Angle already protracted.

Let the *Angle* given be C A B, and 'tis required to find the Quantity thereof: To perform which take in your Compaſſes 60 degrees from your line of *Chords*; and on A, deſcribe the Arch E F; then take in your Compaſſes the Diſtance F H, and apply it to your line of *Chords*; and you will find the *Angle*, C A B to contain 40 degrees. *Fig.* 5.

§. 1.

PROP. VII.

To divide an Angle into two Equal parts.

Let the *Angle* given be BAC, and 'tis required to divide it into two equal parts: To perform which do thus: firſt take in your Compaſſes any convenient diſtance, and placing one foot in A, deſcribe the *Arch* FKHE, *Fig.* 6. then on H, deſcribe the *Arch* KK, and on K, the *Arch* HH; laſtly through the *Interſections* of theſe *two Arches*, draw the line AD, to the *Angular point* A; ſo ſhall the *Angle* BAC, be divided into two equal parts, *viz.* BAD, and DAC; as required.

PROP. VIII.

To divide a right line into any Number of Equal or Unequal parts; or like to any divided line propounded.

Let the line AB, be given to be divided into 5 equal parts; as the line CD. To perform which do thus: firſt on the point C, draw out a line making an *Angle* with CD at pleaſure: then make CF, equal to AB; and joyn their Extremities FD, then draw *Parallel lines* *Fig.* 7. to FD, through all the 5 points of CD, (by the 4 prop. aforegoing) which ſhall divide AB, into 5 equal parts; as required: This way is to be obſerved, when the line given to be divided, is greater than the divided line propounded.

CASE II

§. 1.

CASE II.

But if AB, be ſhorter than the given divided line CD; take the line AB, in your Compaſſes, and on D ſtrike the *Arch* F, then draw the *Tangent* CF, then take the neareſt diſtance from the firſt diviſion of CD, to the *Tangent-line* CF, which diſtance ſhall divide AB into 5 equal parts, as the given divided line CD; as required. *Fig.* 8.

Thoſe two propoſitions well underſtood, doth demonſtrate many other propoſitions, and thereon is grounded the Uſe of the Sector.

PROP. IX.

How to Protract or lay down any of the Regular Figures, called Polygons.

To perform which divide 360 degrees, (the number of degrees in a Circle) by the number of the *Poligon* his ſides: as if it be a *Pentagon* by 5, if a *Hexagon* by 6, *&c.* the Quotient is the Angle of the *Center*; its *Complement* to 180D. (or a Semi-circle) is the Angle at the *Figure*, half whereof is the Angle of the *Triangle* at the *Figure*: Now I will ſhew how to delineate any *Poligon* three ways, *viz.* 1. *by the Angle at the Center*, 2. *by the Angle at the Figure*, 3. *by the Angle of the Triangle at the Figure*: I have hereunto annexed a Table, which gives at the firſt ſight, (without the trouble of Diviſion) 1. the quantity of the Angle at the Center; 2. the quantity of the Angle at the

§. 1. Figure; and 3 the Quantity of the Angle at the Triangle of the Figure, from a Triangle to a Decigon.

Names of the *Poligons.*	Sides	Angles at the Center		Angles at the Figure		Angles at the Trian.	
		D	M	D	M	D	M
Triangle	3	120	00	60	00	30	00
Square	4	90	00	90	00	45	00
Pentagon	5	72	00	108	00	54	00
Hexagon	6	60	00	120	00	60	00
Hepragon	7	51	43½	128	34½	64	17¼
Octogon	8	45	00	135	00	67	30
Nonigon	9	40	00	140	00	70	00
Decigon	10	36	00	144	00	72	00

CONSTRUCTION I.

First by *the Angle at the Center*, to delineate a *Hexagon*, whose Angle at the Center is 60
9. degrees, first lay down an Angle of 60 deg. (by prop. the 5. aforegoing) making its sides of a convenient length at pleasure, then take such a distance from O the Center of the figure, equally on both sides, as may make the third side equal to the side of the *Poligon* given; which here is 100 parts: *Then divide the third side equally into two equal parts, and draw a line through it, from ⊙ the Center: set

** But this in a Hexagon need not be done, because the 3 sides of the Triangle are equal, but in all other Poligons it must be done.*

ſet each half of the ſide of the *Poligon* 100, to wit 50, on each from the middle of the third line † thus having placed the ſide of the *Hexagon* PP, 100 parts, in order; deſcribe the whole *Hexagon* PPPPPP, as was required. §. 1.

† *But if the third line do exceed or be ſhort of the ſide of the Poligon propounded, then by parallels on each ſide, cut the ſides of the Triangle, till you have found by thoſe Interſections where to ſet the line propoſed, in any Poligon,* &c.

CONSTRUCTION II.

Now by the *Angle of the Figure*, to delineate any regular *Poligon*, Let it be required to protract a *Hexagon*, whoſe ſide as afore is 100 parts; firſt I draw a line and make it 100 of thoſe parts, then I find in the precedent Table the Angle of a *Hexagon* at the figure to be 120 degrees: Then on each ſide of the drawn line, I lay down an Angle of 120 deg. (according to the 5 precedent propoſitions) and ſo work 6 times, (or as many times as your *Poligon* hath ſides) making each ſide 100 parts, and each Angle 120 degrees; ſo ſhall you have encloſed the *Poligon* PPPPPP, as required. *Fig.* 10.

CONSTRUCTION. III.

To Protract or lay down a *Hexagon*, or any other regular *Poligon*, *by the Angle of the Triangle*, do thus; Firſt draw the ſide of the *Hexagon* P P, make it 100 parts. I find in the precedent Table that the Angle of the Triangle is 60 deg; then at each end of the line P P, I *Fig.* 11

§. 1. lay down an Angle of 60 deg. (by prop. 5. precedent) and continue the two lines PO, and PO; untill they interſect each other in O: then on O, as a Center (OP: being *Radius*) deſcribe a Circle, and within it deſcribe the *Hexagon* PPPPPP, as you ſee in the figure: and ſo may you delineate any other *Poligon*: whoſe Angels from a *Triangle*, to a *Decigon*, are all ſpecified in the precedent Table.

☞ *Obſerve theſe Rules well, for you will find them of infinite uſe in Fortification, &c.*

Fig. 11.

PROP. X.

To divide a line according to any aſſigned proportion.

Admit the right line given to be AB, and 'tis required to divide the ſame into two parts, bearing proportion the one to the other as the lines E, and F doth: To perform which, firſt draw the line CD, equal to the given line AB: Then draw the line HC, from C, to contain an Angle at pleaſure. Then from C to G, place the line F, and from G, to H, place the line E: Then draw the line HD. And laſtly, draw GK parallel to HD, (by the 4 prop. precedent) ſo is the line DC, equal to AB, and divided into two parts, bearing ſuch proportion to each other, as the two given lines E, and F, as was required.

Fig. 12.

PROP.

§. 1.

PROP. XI.

To two lines given, to find a third proportional to each of them.

Admit the two given lines be A and B, and 'tis required to find a third proportional to A, as A, to B: Firſt make an Angle at pleaſure; as HIK. Then place the line B, from I, unto P; and the line A, from I, unto L; and draw PL. then alſo place the line A, from I unto M, and draw QM, parallel unto LP, (by 4 prop.) ſo ſhall the line IQ, be a third proportional unto the two given lines A, and B, as was required. For as B, is to A, ſo is A, unto the proportional found IQ. *Fig.* 13.

PROP. XII.

To three lines given to find out a fourth proportional unto them.

Admit the three given lines to be A, B, and C; and 'tis required to find a third proportional to them, which ſhall have ſuch proportion unto A, as B, hath unto C. To perform which, firſt make an Angle at pleaſure as DKG, now ſeeing the line C, hath ſuch proportion to B, as the line A, unto the line ſought: Therefore place the line C, from K, unto H and B, from K, to F, and draw FH. Again, place the line A, from K, to I, and draw IE, parallel unto FH, (by 4 prop.) until it cutteth DK, in E; ſo have you the line KE, a fourth proportional, as was required. For as C, is unto B, ſo is A, unto the found line KE. *Fig.* 14.

PROP.

§. 1.

PROP. XIII.

To find a mean proportional Line between any two right lines given.

Let the two given lines be A, and B, between which it is required to find a mean proportional line. To perform which, first joyn the two lines A, and B together, so as they make
Fig. 15. the right line CED: Then describe thereon a *Semicircle* CFD. Then on the point E, erect the *perpendicular* EF, (by 1 prop.) to cut the limb of the *Semi-circle* in F, so shall EF, be a mean proportional line, between the two given lines A, and B, as required.

PROP. XIV.

To find two mean proportional Lines between any two right Lines given.

Fig. 16. Let the two given lines be A, and B; between which 'tis required to find two mean proportionals. To perform which, first make an Angle containing 90 deg. making the sides CD, and CE of a convenient length: then from C, place the line B, unto F, and the line A, from C, unto G; and draw FG, which divide equally in H, and describe the *Semi-circle* F K G. Then take the line B in your Compasses, and placeing one foot in G, with the other make a mark in

And this of all other the Inventions of Plato, Apollonius, Sporus, Architas, Diocles, Nicomedus, *& many other famous Geometricians and Philosophers, I like best for the ready performance of this Conclusion, whose several Methods I could here describe, but for brevity sake do omit them.*

in the limb of the *Semi-circle* in K, then draw ST, in ſuch ſort that it may juſtly touch the Semi-circle in K, and may cut through the two ſides of the Angle, equidiſtant from the Center of the *Semi-circle* H; ſo ſhall SF, and TG, be two *mean proportionals*, betwixt the two given lines A, and B, as required. §. 1.

PROP. XV.

To make a Geometrical ſquare equal to divers Geometrical ſquares.

Let there be given the 5 ſides of five *Geometrical Squares, viz.* A, B, C, D, E; and 'tis required to make one *Geometrical Square*, equal to the ſaid five Sqares: To perform which firſt make a Right Angle as ABC, making its contained ſides of a convenient length. Then from B, place A, to D, and from B, place B, to E, and draw ED. Then place ED, from B, to F, and C, from B, to G; and draw GF. Then place GF, from B, to H, and D, from B, to I; and draw IH. Laſtly from B, unto K, place IH, and from B, unto L, place the line E; and draw LK. So ſhall LK, be the ſide of a Square, equal to the five Squares propounded. *Fig.* 17.

PROP. XVI.

To make a Circle equal to divers Circles propounded.

Let the two Circles propounded be A, and B, and 'tis required to make a third Circle, equal to the ſaid Circles propounded. To perform *Fig.* 18.

§. 2. form which, first take the Diameter, of the lesser Circle A, and place it as a *Tangent*, on the *Diameter* of the greater Circle B, at *right An-*
Fig. 18. *gles*; as ECD. Then draw the *Diagonal* ED, which divide equally in F, on which as a Center describe the Circle K, making E D, the *Diameter* of which Circle K shall be equal unto the two given Circles A, and B, as required *.

* *So after the same manner, may divers Circles be added into one by the help of the former proposition well understood.*

SECT. II.

Of Planometry, *or the way to measure any plain Superfice.*

PLanometry is that part of the *Mathematicks*, derived from that Noble Science *Geometry*, by which the *Superficies* or *Planes* of things are measured, and by which their *Superficial Content* is found, which is done most commonly by the Squares of such Measures, *Viz. a Square Inch*, *Square Foot*, *Square Yard*, *Square Pace*, *Square Perch*, *&c.* That is whose side is an *Inch*, *Foot*, *Yard*, *Pace*, or *Pearch Square*. So that the Content of any Figure is said to be found, when you know how many such *Inches*, *Feet*, *Yards*, *Paces*, *&c.* are contained therein: Thus the End and Scope of *Geometry* is to measure well.

PROP.

§. 2.

PROP. I.

To find the ſuperficial Content of a Geometrical ſquare.

Let the ſide of the Square AA be 4 *Perch*, what is the *Area*, or ſuperficial content thereof? To find which multiply its ſide 4, by its ſelf, it produceth 16, which is the content of that Square AAAA, propounded. *Fig.* 19.

PROP. II.

To find the ſuperficial content of a Parallelogram, or long Square.

Multiply the length in parts, by the breadth in parts; the product is the content thereof. So in the *Parallelogram*, or long Square ABCD, the length of the ſide AB, or CD is 20 *Paces*, and the breadth AC, or BD is 10 paces, and his ſuperficial content is required. I ſay therefore if according unto the Rule, you multiply the length 20, by the breadth 10, it produceth 200 Paces; which is the content of the *Parallelogram* or long Square ABCD. *Fig.* 20.

PROP. III.

To find the ſuperficial Content of any Right-lined Triangle.

Although right-lined Triangles are of ſeveral kinds, and forms; as firſt in reſpect unto their Angles, they are either *Right-angled*, or *Oblique-*

§. 2. *Oblique-angled*, *i. e. Acute-angled*, or *Obtuſe-angled*. Secondly in reſpect of their ſides, they are either an *Equilateral*, *Iſoſceles*, or *Scalenium Triangle*: But now ſeeing they are all meaſur'd by one and the ſame manner, I ſhall therefore add but one Example for all; which take for a general Rule: which is,

The Rule. Multiply the length of the *Baſe*, by the length of the *Perpendicular*, half their product is the *Area* or ſuperficial content thereof. So if the content of the *Triangle* ABC, be required. To find which firſt from the Angle B, let fall the *Perpendicular* DB, on the *Baſe* AC, (by

Fig. 21. prop. 3. §. 1.) let therefore the length of the *Perpendicular* BD be 24, and the *Baſe* AC 44 parts. Now if the *Baſe* AC 44, were multiplyed by BD 24, the product is 1056, half whereof is 528, the Content of the *Triangle* ABC, propounded.

PROP IV.

To find the ſuperficial Content of a Rhombus.

Firſt let fall a *Perpendicular* from one of the *Obtuſe-angles*, unto its oppoſite ſide, (by prop. 3. §. 1.) and then Multiply the length of the ſide thereof, by the length of the *Perpendicular*, their product is the Content thereof.

So in the *Rhombus* ABCD, the ſide AC, or

Fig. 22. BD is 16 *Inches*, and the *Perpendicular* KC is 14 *Inches*, which multiplyed into the ſide 16, produceth 224 *Inches*; which is the *Area*, or ſuperficial Content, of the *Rhombus* ABCD, propounded.

PROP.

PROP. V. §. 2.

To find the ſuperficial content of a Rhomboides.

Frſt let fall a *Perpendicular*, as in the former propoſition, then the length thereof multiply by the length of the *Perpendicular*; the product is the *Area*, or ſuperficial content thereof. For in the *Rhomboides* EDAH, whoſe length AH, or ED is 32 *Feet*, and the length of the *Perpendicular* HK is 16 *Feet*, which multiplyed together produceth 512 *Feet*, which is the *Area* or ſuperficial content of the *Rhomboides* AHED, propounded. *Fig.* 23.

PROP. VI.

To find the ſuperficial Content of any Poligon, or many equal ſided Superficies.

Firſt from the *Center* unto the middle of either of the ſides of the *Poligon*, let fall a *Perpendicular*, (by 3. prop §. 1.) Then multiply the length of half the *Perifery*, by the *Perpendicular*, the product ſhall be the *Superficial Content* of the *Poligon*.

Admit the *Poligon* to be an *Hexagon* AAAAAA, whoſe ſide AA is 22 *Feet*, and the *Perpendicular* BE 19 *Feet*; now, if 66 half the *Perifery*, be multiplyed by 19 it produceth 1254 *Feet*; which is the *Content* of the *Poligon* AA, &c. as required. *Fig.* 24.

PROP.

§. 2.

PROP. VII.

To find the superficial Content of a Circle.

Multiply half the *Circumference*, by one half of the *Diameter*, their product is the *superficial Content* thereof.

Admit the *Circumference* of a *Circle* ACBD, be 44 *Inches*, what is the *Area* or *Content* thereof. (by the 9. prop. §. 2.) I find the *Diameter* to be 14 *Inches*, therefore I say if 22, half the *Circumference*, be multiplied by 7, half the *Diameter*, it shall produce 154 *Inches*; which is the *superficial Content* of the *Circle* ACDB, as required.

Fig. 25.

PROP. VIII.

By the Diameter of a Circle given, to find the Circumference.

Suppose the *Diameter* be 14, what is the *Circumference*? The *Analogy* or *Proportion* holds thus, as 7, to 22, so is 14, unto 44, the *Circumference* required.

PROP. IX.

By the Circumference of a Circle given, to find the Diameter.

Suppose the *Circumference* of a *Circle* be 44, what is the *Diameter*? the *Analogy* or *Proportion* is, as 22, to 7, so is 44, unto 14, the *Diameter* required.

Now

Now the proportion of the *Diameter*, unto the *Circumference* is as 7, unto 22; or as 113, to 355,; or as 1, unto 3, 1415926, *&c.* so is the *Diameter* to the *Circumference.* §. 2.

PROP. X.

By the Content of a Circle given, to find the Circumference.

Suppose the Content of a *Circle* be 154, what is the *Circumference*, the *Analogy* or *Proportion?*

As 7, unto 4 times 22, which is 88, so is 154 the Content of the given *Circle*; to the square of the *Circumference* 1936, whose root being Extracted, as is taught (in prop. 8. §. 1. chap. 1.) gives the *Circumference* 44, as required.

PROP. XI.

By the Content of a Circle given, to find the Diameter.

Suppose the *Superficial Content* of a *Circle* be 154 parts, what is the *Diameter* thereof? to find which this is the *Analogy* or *Proportion.*

As 22,
To 4 *times* 7, *which is* 28,
So is 154, *the given Content,*
To the *Square of the Diameter* 196, whose *Root* being Extracted (by 8 prop. chap. 1. §. 1.) giveth the *Diameter* 14, as required.

§. 2.

PROP. XII.

By the Diameter of a Circle given to find the side of a square equal thereto.

To find which this is the *Analogy* or *Proportion.*

As 1, 000000,
To 0, 886227.
So is the *Diameter of the Circle propounded.*
To the side of a Square, whose *superficial Content*, is equal unto the *superficial Content*, of the *Circle* propounded.

PROP. XIII.

By the Circumference of a Circle given, to find the side of a square equal to it.

This is the *Analogy* or *Proportion.*
As 1. 000000,
To 0. 282093.
So is the Circumference of the Circle propounded, *to the side of a Square equal to the Circle.*

PROP. XIV.

By the Content of a Circle given to find the side of a square equal to it.

To do which, Extract the *Square-Root* of the Content propounded, (by prop. 8 chap. 1. §. 1.) so is the *Root*, the side of a *Geometrical Square*, equal thereunto.

PROP

§. 2

PROP. XV.

By the Diameter of a Circle given, to find the side of an Inscribed Square.

This is the *Analogy* or *Proportion.*
As 1. 000000,
To 0. 707107,
So is the Diameter of the Circle propounded,
To the side of the inscribed Square.

PROP. XVI.

By the Circumference of a Circle given, to find the side of an Inscribed Square.

This is the *Analogy*, or *Proportion.*
As 1. 000000,
To 0. 225079.
So is the Circumference of the Circle propounded, *To the side of the inscribed Square.*

PROP. XVII.

To find the Superficial Content of an Oval, or Elleipsis.

Let the *Oval* given be ABCD, and 'tis required to find the *Area* or *Superficial Content* thereof? To do which multiply the length A 40 *Inches*, by the breadth CD 30 *Inches*, the *Product* is 1200. Which divide by 1. 27324; the *Quotient* is 942$\frac{42}{100}$ parts. Which is the *Area* or *Superficial Content* of the *Oval* ABCD propounded *Fig.* 26.

§. 2.

PROP. XVIII.

To find the Superficial Content of any Section, or Portion of a Circle.

Multiply half the *Circute* of the *Section*, by the *Semidiameter* of the whole *Circle*, and the product thence arising is the *Area* or *superficial Content thereof.*

Fig. 27. Suppose there be a *Circle* whose *Diameter* is 14 parts, and the *Circute* of the *Quadrent* ABC is 11 parts, and the Content of the said *Quadrent* is desired? To find which multiply $5\frac{1}{2}$ or, 5., 5 half the *Circute* of the *Quadrent*, by 7 the *Semidiameter*, the product is $38,\frac{5}{10}$, which is the Content of the *Quadrent* ABC propounded.

---

§. 3.

SECT. III.

Of STEREOMETRY, *or the way how to measure any Regular Solid.*

Stereometry is that part of the *Mathematicks*, springing from *Geometry*, by which the Content of all *solid Bodies* are discovered by two *Multiplications*, or three *Dimentions* and is valued by the *Cube* of some famous Measure; as an *Inch-Cube*, *a Foot-Cube*, *a Yard-Cube*, *or a Perch-Cube*, &c.

PRO

§. 3.

PROP. I.

To find the ſolid Content of a Cube.

Multiply the ſide into its ſelf, and that product by its ſide again; their product is the ſolid Content thereof.

Suppoſe there be a *Cube* A, whoſe ſide is 2 Feet; and his ſolid Content is required? I ſay if his ſide 2, be multiplyed by its ſelf, it produceth 4, which again multiplyed by 2, it produceth 8 Feet, which is the ſolid Content of the *Cube* propounded. *Fig.* 28.

PROP. II.

To find the ſolid Content of a Parallelepipedon.

Firſt get the *Superficial Content* of the End, (by prop. 1, or 2, §. 2.) which multiply into the length, the product is the *ſolid Content.*

Suppoſe there be a *Parallelepipedon* B, whoſe ſides of the *Baſe* is 40, and 30 *Inches*, and length 120 *Inches*, and his *Solid Content* is demanded? I ſay if you multiply 30, by 40, the product is 1,200, which is the *ſuperficial Content* at the *Baſe.* Which multiplyed by the length 120 Inches produceth 144000 Inches, which is the *ſolid Content* of the *Parallelepipedon* B, propounded. *Fig.* 29.

§. 3.

PROP. III.

To find the solid Content of a Cylinder.

First get the *superficial Content* of the Circle at the *Base*, (by prop. 7. §. 2.) and by it multiply its length, their product is the *solid Content* thereof.

Fig. 30. Suppose there be a *Cylinder* as D, whose *Diameter* of the *Circle* at the *Base* is 7 parts, and the length of the *Cylinder* is 14 parts, and 'tis required to find the *solid Content* thereof? First I find the *superficial Content* of the *Base* to be 38.5, which multiplied into 14 the length, giveth 539 parts, which is the *solid Content* of the *Cylinder* propounded.

PROP. IV.

To find the solid Content of a Pyramid.

First get the *superficial Content* of the *Base* of the *Pyramid*, (by some of the aforegoing propositions in *Planometria*) and then multiply that into $\frac{1}{3}$ of his *Altitude*, the product is the *solid Content* thereof.

Suppose there be a *Pyramid* H, whose side of the *Base* is $4\frac{1}{2}$ parts, or $4\frac{5}{10}$, and his *Altitude* 12 parts, and his *solid Content* is required? First I find, (by prop. 1. §. 2.) the *superficial Content* Fig. 31. of the *Base* to be $20\frac{25}{100}$ or $20\frac{1}{4}$, which multiplyed by 4, (which is $\frac{1}{3}$ of the *Altitude* 12) produceth 81 parts, for the *solid Content* of the *Pyramid* propounded.

PROP.

§. 3.

PROP. V.

To find the ſolid content of a Cone.

Firſt find the *ſuperficial Content* of the *Circle* at the *Baſe*, (by prop. 7. §. 2.) then multiply it by ⅓ of its *Altitude* or Heighth, the product is the *ſolid Content* thereof.

Suppoſe there be a *Cone* as B, whoſe *Diameter* of the *Baſe* is 7, and his *Altitude* or Heighth is 15 parts, and his *ſolid Content* is required? Firſt I find the *ſuperficial Content* of the *Baſe* to be 38½ or 38. 5; which multiplyed into 5, (⅓ of its *Altitude* or Heighth) produceth 192. 5, or ⅓, which is the *ſolid Content* of the *Cone* propounded. *Fig.* 32.

PROP. VI.

By the Diameter of a Globe to find his ſolid Content.

This is the *Analogy* or *Proportion.*

As 6 *times* 7, *which is* 42.

Is to 22,

So is the Cube of the Diameter of the Sphere, or Globe propounded.

To the ſolid Content thereof.

Suppoſe there be a *Sphere* or *Globe*, whoſe *Diameter* is 12 Inches; what is the *ſolid Content* thereof? ſay, (ſee the *Globe* R.)

As 42, *Fig.* 33.

Is to 22,

So is 1728, *the Cube of the Diameter,*

To the solid Content $905\frac{6}{42}$ or $\frac{1}{7}$ *of the Globe, or Sphere* propounded: This and all other such like Propositions, are performed by the help of the first Proposition, of the first Chapter of this Book.

☞ *Note that every Sphere is equal unto two Cones, whose Height and Diameter of the Base is the same with the Axis of the Sphere. And a Sphere is two thirds of a Cylinder, whose Height and Diameter of the Base is the same with the Axis of the Sphere: according unto the 9th. Manifestation of the first Book of* Archimedes *of the Sphere and Cylinder*

PROP. VII.

By the Circumference of a Sphere, or Globe, to find his solid Content.

This is the *Analogy* or *Proportion.*
As 1. 000000,
To 0. 016887,
So is the Cube of the Circumference of the Globe or Sphere propounded
To the solid Content thereof.

PROP. VIII.

By the Axis of a Globe, to make a Cube equal thereunto.

This is the *Analogy* or *Proportion.*
As 1. 00000,
To 0. 80604,
So is the Axis of the Sphere propounded,
To the *Cube-Root*, which shall be equal to it.

PROP.

§. 3.

PROP. IX.

By the Circumference of a Globe, to make a Cube equal thereunto.

This is the *Analogy* or *Proportion.*

As 1. 000000,

To 0 256556.

So is the Circumference of the Globe propounded,

To the *Cube-Root*, which ſhall be equal to the *Sphere*, or *Globe*, propounded.

PROP. X.

By the ſolid Content of a Sphere or Globe, to make a Cube equal thereunto.

Extract the *Cube-root* of the *ſolid Content* of the *Sphere* or *Globe*, (by prop. 9. §. 1. chap. 1.) ſo ſhall the Root, ſo found, be the ſide of a *Cube*, equal unto the *Globe* or *Sphere* propounded.

PROP. XI.

A Segment of a Sphere being given to find the ſolid Content thereof.

To find which firſt ſay, *As* the *Altitude* of the other *Segment*, is to the *Altitude* of the *Segment*

§. 3. *ment* given: so is that *Altitude* of the other *Segment* increased by half the *Axis*, unto a *fourth*: Then say, *As* 1, *to* 1, 0472, *so is the product of the Quadrant of half the Chord of the Circumference of that Segment, multiplyed by that fourth, To the solid Content of the Segment propounded.*

CHAP.

---

§. 1.

CHAP. V.

Of TRIGONOMETRY.

Or the Doctrine of Triangles.

SECT. I.

Some general Maxims, belonging to plain or Right-lined Triangles.

TRIGONOMETRY is neceſſary in moſt parts of the *Mathematicks*, and herein indeed conſiſteth the moſt frequent uſe of the *Logarithms*, *Sines*, *Tangents*, and *Secants*: It is converſant in the meaſuring of *Triangles*, *Plain* or *Spherical*, comparing their *Sides*, and *Angles* together; according unto their known *Analogies*, or *Proportions*: So that any three parts of a *Triangle* being given, the other parts may be found out, and known: Now in the *Doctrine* of *Right-lined Triangles*, it will be neceſſary to know theſe *Maxims* following.

1. That

§. 3. 1. That a *Right-lined Triangle*, is a Figure constituted, by the Conjunction, or Intersection, of the three Right, or Streight-lines thereof; in their Angles or Meeting-places. So that every *Triangle* hath six distinct parts, *Viz. Three Sides*, and *three Angles.*

Fig. 34. 2. That all *Right-lined Triangles*, are either *Right-angled*, That is, which hath one *Right-Angle*, as ABC Fig. 34. *Or Oblique-angled*, whose three *Angles* are all *Acute*; that is, less than a *Quadrant*, or 90 deg; or else they have *One Angle Obtuse*, or greater than a *Quadrent*: *Fig.* 36. So all *Triangles*, that have not one *Right-angle*, are called *Oblique-Triangles*; as Fig. 36. to wit, the *Triangle* ABC.

3. That the three *Angles*, of any *Right-lined Triangle*, are equal unto two *Right-angles*; or 180 *Degrees.* So that any two of their *Angles* being known, the third *Angle* is also found, being the *Complement* of the other two; unto 180 *Degrees:* But this is more readily found in a *Rectangled Triangle*, for the *Rectangle* being a *Quadrent*, or 90 degrees, one of the acute *Angles* therefore being given, the other is readily known, being the *Complement* thereof unto 90 *Degrees.*

Fig. 35. 4 That the three sides, comprehending the *Triangle*, some call *Leggs*, others *Sides*, but in *Rectangled Triangles*, as in the *Triangle* ABC, I call AB, *the Base*, BC the *Cathetus* or *Perpendicular*; and AC the *Hypothenuse.*

5. That the *Sines*, of the *Angles* are proportional unto their opposite *Sides*; and their *Sides*, to their opposite *Angles.* So that if the *Side* of a *Triangle* were desired, put the *Sine* of the opposite

site *Angle* in the first place. Also if an Angle be required, put the *Logarithm* of his opposite side in the *first place.* §. 3.

6. That the sides of any *Rectangled Triangle* may be measured by any *Scale* of equal parts, as *Inches, Feet, Yards, Poles, Miles, Leagues,* &c.

7. That if an *Angle* propounded, be greater than 90 *deg.* and so not to be found in the *Tables,* take the *Complement* thereof, unto 180 *deg.* and work by the *Sine,* or *Tangent* thereof, and the work will be the same.

And here for the more short, and speedy performance of these conclusions in *Trigonometry*; I have annexed, and used, these following *Symbols*; which I would have you take notice of.

= *Equal, or Equal to.*	X *Difference.*
✠ *More.*	S *Sine.*
— *Less.*	Sc *Co-sine.*
x *Multiplyed by.*	T *Tangent.*
° *Degrees as* 15°.	Tc *Co-tangent.*
′ *Minutes as.* 40′.	Se *Secant.*
cr. *A Side.*	Sec *Co-secant.*
cr^{s}, *Sides.*	Co. Ar. *Compl. Arithmetic.*
V An Angle.	R *A Right-angle.*
VV Angles.	2 R *Two Right-angles.*
Z *Sum.*	Q *Square.*

SECT.

§. 2.

SECT. II.

Of Plain Rectangled Triangles.

PROP. I.

Two Angles and the Base of a Rectangled Triangle given, to find the other parts.

Fig. 34. ADmit the *Triangle* given be ABC: Now the *Angle* at B, is an *Angle* of 90°, or a *Right-angle*; And the *Angle* at C is 57° 35′, and the *Base* AB; is 736 parts.

Now first I find the *Angle* at A, to be 32° 25′: it being the *Complement* of the *Angle* at C, unto 90°: Secondly, to find the *Cathetus*, or *Perpendicular*, this is the *analogy* or *proportion.*

As S, *V*, C, 57° 35′	9.92643
To Log. AB. *Base* 736 *parts*	2.86687
So is S. *V.* A. 32° 25′	9.72922
	12.59609
To Log. of the Cathetus, or Perpendicular BC 467 $\frac{4}{10}$ *parts.*	2.66966

Add the *Log.* of the third and second *Terms* together, and from their Sum, deduct the *Log.* of the first number, so is the Remainder, the *Log.* of the

Observe this for a general Rule in Trigonometry.

the fourth *Term*, or Number sought, as you see in the aforegoing *Example*. §. 2.

Thirdly to find the *Hypothenuse* AC, the *Analogy* or *Proportion* hold thus.

As S. *V*, C 57° 35′,
To Log. Base AB 736 *parts.* *Fig.* 34
So Radius or S. 90°,
To Log. Hypothenuse AC $871\frac{8}{10}$ *parts required*: Thus are the three required parts, of the given *Triangle* ABC found, *viz.* the *Angle* A to be 32° 25′, the *Cathetus* BC to be $467\frac{4}{10}$ parts, and the *Hypothenuse* AC to be $871\frac{8}{10}$ parts, as was so required to be found.

PROP. II.

The Hypothenuse, *Base, and one of the Angles Of a Rectangled Triangle given, to find the other parts thereof.*

In the *Triangle* ABC, the *Hypothenuse* AC is $871\frac{8}{10}$ parts, the *Base* AB is 736 parts, and the *Angle* at B, is known to be a *Right-angle*; or 90°: *First* to find the *Angle* at the *Cathetus* C, the *analogy* or *proportion* holds thus.

As Log. Hypothen: AC $871\frac{8}{10}$ *parts* *Fig.* 34
To Radius or S. 90°.
So Log. Base AB 736 *parts*,
To the S. *V. at Cathetus* C 57° 35′.

Secondly, now having found the Angle at the *Cathetus* C, to be 57° 35′; I say the Angle of the *Base* A is 32° 25′, being the *Compl.* of the Angle C, unto 90°.

Thirdly to find the *Cathetus* BC, this is the *analogy*, or *proportion*.

As

As Radius or S. 90°,
To Log. Hypothen. AC 871 $\frac{8}{10}$ *parts*,
Fig. 34. *So S. V. at Base* A 32° 25′.
To Log. Cathetus BC, 467 $\frac{4}{10}$ *parts required*.

It may also be found, as in the former Proposition.

PROP. III.

In a Rectangled Triangle, the Base, and Cathetus *given to find the other parts thereof.*

In the Triangle ABC, *the Base* AB is 736 parts, and the *Cathetus* BC is 467 $\frac{4}{10}$ parts, and the Angle B, between them is *a right angle*; or 90°: And here you may make either side of the Triangle, *Radius*, but I shall make BC, the *Cathetus Radius*, and then to find the Angle at the *Cathetus* C, this is the *Analogy* or *Proportion*.

Fig. 35. *As Log. Cathet.* BC 467 $\frac{4}{10}$ *parts*,
To Radius or S. 90°.
So Log. Base AB 736 *parts*,
To T. V. Cathe. C 57° 35′, *as required*.

Secondly, I find the other Angle, at A to be 32° 25′, it being the *Complement*, to C 57° 35′, unto 90°.

Thirdly, To find out the *Hypothenuse* AC, this is the *analogy* or *proportion*.

As S. V. Cathe. C 57° 35′,
To Log. Base AB 736 *parts*,
So Radius or S. 90°,
To Log. Hypothenuse AC 871 $\frac{8}{10}$ *parts*, *required*. But making the *Base* AB *Radius*, you may find the *Hypothenuse* AC, by this *analogy* or *proportion*.

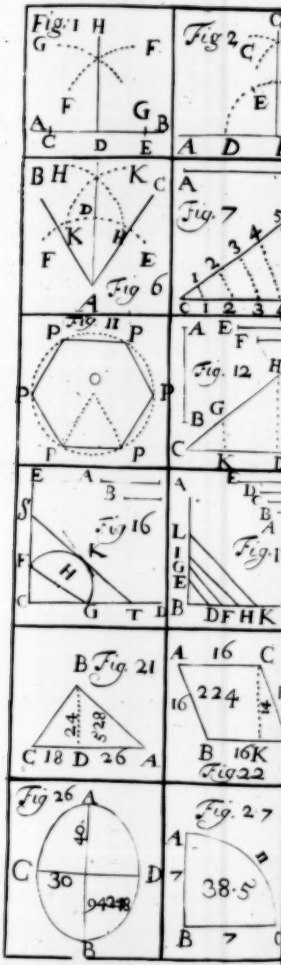


Fig. 1
Fig 2
Fig 6
Fig. 7
Fig 11
Fig. 12
Fig 16
Fig. 21
Fig 22
Fig 26
Fig. 27

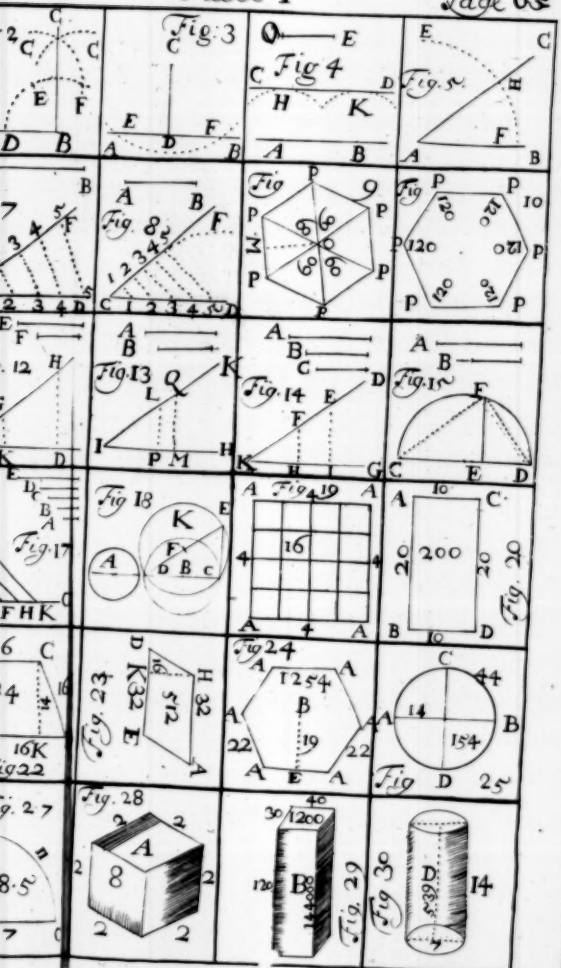


Fig 3
Fig 4
Fig 5
Fig 8
Fig 9
Fig 10
Fig 13
Fig 14
Fig 15
Fig 17
Fig 18
Fig 19
Fig 23
Fig 24
Fig 25
Fig 28
Fig 29
Fig 30

As Radius or S. 90°,
To Log. Baſe AB 736 *parts.*
So Sc. *V. Baſe* A 32° 25′,
To Log. Hypothenuſe AE 871 $\frac{8}{10}$ *parts required,* and thus you have all the parts of the Triangle propounded. §. 2. *Fig.* 35.

PROP. IV.

The Baſe, and Hypothenuſe, with the Angle between them given, to find the other parts of a Rect-angled Triangle.

In the Triangle ABC, the *Baſe* AB is 736 parts, and the *Hypothenuſe* AC is 871 $\frac{8}{10}$ parts, and the Angle A included between them is 32° 25′. *Firſt* to find the Angles, and firſt remember that the Angle B is a right Angle; or 90°. *Secondly*, that the Angle at C, is the *Complement* to the Angle at A 32° 25′ unto 90°: and therefore is 57° 35′: Now theſe being known, you may find the *Cathetus*, by this *analogy* or *proportion*. *Fig.* 35.

As S. V. Cathe. C 57° 35′,
To Log. Baſe AB 736 *parts.*
So S. V. Baſe A 32° 25′,
To Log. Cathe. BC 467 $\frac{4}{10}$ *parts required.* Thus I have ſufficiently explained all the *Caſes* of *Plain Rect-angle Triangles*, for to theſe rules they may be all reduced.

F SECT.

§. 3.

SECT. III.

Of Oblique-Angled Plain Triangles.

PROP. I.

Two Angles, and a side opposite, in an Oblique-Angled Triangle given, to find the other parts thereof.

IN the Triangle ABC, the Angle at A is 50°, and at C is 37°, and the side AB is 30 parts, and opposite to the Angle C.

First, to find the Angle B, remember that (as 'tis said, in the third *Maxim* aforegoing) 'tis the *Complement*, to the Angles A 50°, and C 37°, to 180°, and therefore is the Angle at B 93°.

Fig. 36. *Secondly*, having thus found the Angles, the two unknown sides, may be found by the proportion they bear to their opposite Angles, for that proportion holds also in these; thus to find the side BC, this is the *analogy or proportion.*

As S. *V.* C 37° 00′,
To Log. side AB 30 *parts.*
So S. *V.* A. 50° 00′,
To Log. side BC 38 $\frac{12}{100}$ *parts required to be found.*

But it may be more readily found, and performed in such case as this, where you have a *Sine*, or *Tangent*, in the first place, by the *Arithmetical Complement* thereof, and so save the *Substraction.*

Now

§. 3.

☞ *The Rule to find the Complement Arithmetical, of any Logarithm Number.*

Now the readieſt way to find the *Arithmetical Complement* is that of *Mr. Norwood*, in his *Doctrine of Triangles*; which is thus: begin with the firſt Figure towards the left hand of any *Number* and write down the *Complement*, or the remainder thereof, unto 9: —— 9. 962398.
And ſo do with all the reſt of the *Figures*, as you ſee here done. —— 0. 037602.

Saying 9, wants of 9, 0: and again 9, wants 0: 6, wants 3; 2, wants 7: 3, wants 6; 9, wants 0: only when you come to the laſt Figure to the right hand, take it out of 10, ſo 8, wants 2; of 10: Thus you may readily find the *Co-Ar.* of any *Sine*, almoſt as ſoon as the *Sine* it ſelf.

But if you want the *Complement Arithmetical* of any *Tangent*, you may take the *Co-tang.* which is exactly the *Co-Arith.* of the double *Radius*, ſo that the *Tangent*, and *Co-tangent*, of an *Arch* makes exactly 20. 000000.

Now if the *Radius* be in the firſt place, then there is no need of taking the *Co-Arith.* of the firſt Number, only you muſt cut off, the firſt 1, to the left hand thus *x*, and you will have the *Logarithm* of the Number deſired.

Thirdly, now to find the ſide AC, by the oppoſite Angle B; which is 93° 00′: (And ſeeing the Angle B, exceeds 90°, you muſt work by the *Complement* to 180°) as in the ſeventh Work in page 61 is taught.

§. 3.

Co-Arith.

As S. *V.* C. 37° 00′. ——————— 0. 22054.
To Log. cr. AB 30 *parts* ——————— 1. 47712.
Fig. 36. *So is* Sc. *V.* B. 87° 00′, ——————— 9. 99940.

To Log. cr. AC $49\frac{78}{100}$ *parts.* ——— *x*1. 69706.

Thus having found all the parts of the *Triangle* propounded, *Viz.* The Angle B, to be 93° 00′, the side AC to be $49\frac{78}{100}$ parts, and the side BC to be $38\frac{19}{100}$ parts, as was required to be found.

PROP. II.

Two sides, and an Angle opposite to one of them in an Oblique-angled Triangle given, to find the other parts thereof.

In the Triangle ABC, the side AB is 30 parts, and the side AC, is $49\frac{78}{100}$ parts, and the opposite Angle C, is 37° 00′.

Fig. 36. *First*, To find the Angle at B, this is the *Analogy* or *Proportion.*

As Log. cr. AB 30 *parts,*
To S. *V.* at C 37° 00′.
So Log. cr. AC $49\frac{78}{100}$ *parts,*
To Sc. *V.* B 93° 00′, *as was required to be found.*

Now seeing that the Angle C, is 37° 00′, and the Angle B, is 93° 00′, which makes 130° 00′, therefore must the Angle A be 50° 00′; the

Com-

Complement to 180° : ſo having found all the three Angles, you may find the other ſide CB, $38\frac{10}{100}$ parts, as afore in the firſt propoſition, by his oppoſite Angle. §. 3. *Fig.* 36.

PROP. III.

Two Sides of an Oblique-angled Triangle, with the Angle included between them given, to find the other parts thereof.

In the Triangle ABC, the ſide AC is $49\frac{78}{100}$ parts, the ſide DB is 30 parts, and the Angle A between them is 50° 00′; and 'tis required to find the other parts of the Triangle propounded. To reſolve this Concluſion, let fall a *Perpendicular* DB, from the Angle B, on the ſide AC; (by prop. 3. §. 1. chap. 4.) and then proceed thus.

Firſt, Seeing the *Oblique-angled Triangle*, ABC is divided into two *Rectangled Triangles*, *Viz.* ADB, and BDC: Now I will begin with the Triangle ADB, in which is given the Angle A 50° 00′, and the Angle D is a right Angle, or 90°, and the ſide AB 30 parts, and the ſides AD, and DB, and the Angle at B, are required. *Fig.* 37.

Firſt to find the Angle at B, remember that it is the *Complement* unto the Angle A 50° 00′, unto 90° 00′, and therefore muſt the Angle B be 40° 00′; Now for to find the *Cathetus* BD, (as in prop. 1. and 2 §. 2. chap. 5.) by the Rule of oppoſition, the *Analogy* or *Proportion* holds thus.

§. 3. *As Radius* or S. 90°,
To Log. Hypoth. AB 30 *parts.*
So S. *V.* at A 50° 00′,
To Log. Cath. BD $22\frac{98}{100}$ *parts ſought.*

And AGAIN, ſay.

As Radius or S. 90°,
To Log. Hypoth. AB 30 *parts.*
So S. *V. at* B 40° 00′,
To Log. Baſe AD $19\frac{28}{100}$ *parts ſought.*

Thus in the Triangle ADB, you have found the *Angle* B, to be 40° 00′, the *Cathetus* BD, to be $22\frac{98}{100}$ parts; and the *Baſe* AD to be $19\frac{28}{100}$ parts, as was ſo required.

Now for the other Triangle which is BDC, in which there is given the ſide BD, $22\frac{98}{100}$ parts, and the Angle at D, is a *Right-angle*, or 90°, and the ſides DC, and CB, and the Angles B, and C, are required.

Fig. 37. Firſt to find the ſide DC, ſubſtract AD, $19\frac{28}{100}$ parts, out of AC, $49\frac{78}{100}$ parts; there remains the *Baſe* DC; $30\frac{50}{100}$ parts: Thus have you the two ſides of the Triangle, to wit the *Baſe* DC, $30\frac{50}{100}$ parts, and the *Cathetus* BD, $22\frac{98}{100}$ parts, and the Angle D between them is a *Right-angle* or 90°. Now you may find the Angle at B, by the *Tangent* (as in prop. 3. §. 2. chap. 5.) thus.

As Log. Cath. BD, $22\frac{98}{100}$ parts,
To Radius or S. 90°.
So Log. Baſe CD $30\frac{50}{100}$ parts.
To T. *V.* B. 53° 00′.

Secondly, For the Angle C, remember 'tis the *Complement* of the Angle B, 53°, to 90°; and therefore is the Angle C, 37° 00′, required.

Thirdly,

Thirdly, To find the *Hypoth.* BC, this is the *Analogy* or *Proportion*. §. 3.

As S. *V.* B. 53° 00′,
To Log. Base DC 30$\frac{10}{100}$ parts.
So Radius or S. 90°,
To Log. Hypoth. BC 38$\frac{12}{100}$ parts: Thus have you found all the required parts of the Triangle ABC propounded, *viz.* the Angle C to be 37° 00′, the Angle B, to be 93° 00′, * and the *Side* BC, 38$\frac{12}{100}$ parts, as required to be found.

* *That is equal unto the two Angles B* 40° *and B.* 53° *as afore in the former Proposition.*

Another way to perform the same.

Take the Sum of the two sides, and the difference of the two sides; and work as followeth.

Side.	AB	30$\frac{00}{100}$
Side.	AC	49$\frac{28}{100}$
Sum.		79$\frac{28}{100}$
Difference.		19$\frac{28}{100}$

Now to find the two Angles B, and C, this is the Manner, and by this *Analogy* or *Proportion*, they are found out and known. *Fig.* 37.

As Log. Z. cr^{s}. AB, and CA, 79$\frac{28}{100}$ *parts*,
To Log. X. cr^{s}. AB, and CA; 19$\frac{28}{100}$ *parts*,
So T. *of* $\frac{1}{2}$ *VV unknown*, 65° 00′,
To T. $\frac{1}{2}$ X. of *VV*, 28° 00′.

This difference of Angles 28° 00′, add unto 65° 00′, (half the difference of the unknown Angles) and it shall produce 93° 00′, which is the greater Angle, and substracted from it, leaves 37° 00′, which is the lesser Angle C: so have you the required Angles.

§. 3.

PROP. IV.

The three sides of an Oblique-angled Triangle given, to find the Angles.

In the Triangle ABC, the side AC, is $49\frac{78}{100}$ parts, the side AB, is 30 parts, and the side BC, is $38\frac{19}{100}$ parts; and the three Angles of the Triangle are required.

Side.	AB	$30\frac{00}{100}$
Fig. 37. Side.	BC	$38\frac{19}{100}$
Sum.		$68\frac{19}{100}$
Diff.		$08\frac{19}{100}$

The resolution of this Conclusion is thus. Take the *Summ* and *Differ.* of the two sides AB, and BC; And then work as follows: To find a *Segment* of the *Base* AC, to wit CE; say:

As Log. Base AC, $49\frac{78}{100}$ *parts*,
To Z. cr^{s}. AB, and BC; $68\frac{19}{100}$ *parts*,
So X. cr^{s}. AB, and BC; $8\frac{19}{100}$ *parts*,
To Log. of a Segment of the Base AC, *to wit* CE $11\frac{22}{100}$ *parts.*

This *Segment* of the *Base* CE, $11\frac{22}{100}$ parts, being substracted from the whole *Base* AC, $49\frac{78}{100}$ parts, the remainder is EA $38\frac{56}{100}$ parts, in the middle of which as at D, the Perpendicular DB, will fall from the Angle B; and so divide it into two *Rectangled Triangles*, to wit, ADB, and CDB, whose Base DA is $19\frac{28}{100}$ parts, which taken from AC $49\frac{78}{100}$ parts, leaves the Base of the greater Triangle CD $30\frac{50}{100}$ parts.

Fig. 37.

Now having the two *Bases* of these two *Triangles*, and their *Hypothenuses*; to wit CD $30\frac{50}{100}$ parts, DA $19\frac{28}{100}$ parts, CB $38\frac{19}{100}$ parts, and BA 30 parts,

parts; you may find all their Angles, by the Rule of Oppoſite ſides, to their Angles as afore. §. 3.

I. *In the Triangle* CDB.

To find the *Angles*, this is the *Analogy* or *Proportion.*

As Log. BC $38\frac{19}{100}$ parts,
To Radius or S. 90°.
So Log. DC $30\frac{10}{100}$ parts,
To S. V. B 53° 00′: *whoſe Complement* is the Angle at C 37° 00′ unto 90: or a *Quadrant.* *Fig.* 37.

II. *In the Triangle* ADB.

To find the Angles, this is the *Analogy* or *Proportion.*

As Log. AB, 30 *parts,*
To Radius or S. 90°.
So Log. AD $19\frac{28}{100}$ *parts,*
To S. V. B, 40° 00′.

The *Complement* whereof, unto 90° 00′, is the *Angle* at A 50° 00′.

Now in the firſt Triangle CDB, there is found the Angle C, to be 37° 00′, and the Angle B, to be 53° 00′.

In the ſecond Triangle ADB, there is found the Angle A; to be 50° 00′, and the Angle B, to be 40° 00′.

Now the two Angles at B, to wit 53° 00′; and 40° 00′; makes 93° 00′, which is the Angle of the *Oblique-angled Triangle* ABC, at B: Thus the three Angles of the ſaid given *Triangle* ABC, are found as was required, *viz.* the Angle A to be 50° 00′, the Angle B to be 93° 00′, and the Angle C to be 37° 00′, as ſought.

Thus

§. 3. Thus I have ſufficiently, fully and plainly explained all the Caſes of *Plain Right-lined Triangles*, both *Right* and *Oblique-angled*: I ſhall now fall in hand with *Spherical Triangles*, both *Right* and *Oblique-angled.*

---

§. 4.

SECT. IV.

Of Spherical Rectangled Triangles.

And here firſt it will be neceſsary alſo to underſtand thoſe few general Maxims or Rules, that are of ſpecial Moment, in the Doctrine of Spherical Triangles.

1. THat a *Spherical Triangle* is comprehended and formed, by the Conjunction and Interſection of three *Arches* of a *Circle*, deſcribed on the *Surface* of the *Sphere* or *Globe.*

2. That thoſe *Spherical Triangles*, conſiſteth of ſix diſtinct parts, *viz.* three Sides and three Angles, any of which being known, the other is alſo found out and known.

3. That the three Sides of a *Spherical Triangle*, are parts or *Arches* of three great Circles of a *Sphere*, mutually interſecting each other: and as plain or Right-lined Triangles, are meaſured by a Meaſure, or *Scale* of equal parts: So theſe are meaſured, by a *Scale* or *Arch* of equal *Degrees.*

4. That

4. That a *Great Circle* is ſuch a Circle that doth beſſect the *Sphere*, dividing it into two equal parts; as the *Equinoctial*, the *Ecliptick*, the *Meridians*, the *Horizon*, &c. §. 4.

5. That in a *Right-angled Spherical Triangle*, the Side ſubtending the Right-angle we call the *Hypothenuſe*, the other two containing the Right-angle we may ſimply call the *Sides*, and for diſtinction either of them may be called the *Baſe* or *Perpendicular*.

6. That the Summ of the Sides of a *Spherical Triangle* are leſs than two *Semicircles* or 360°.

7. That if two Sides of a *Spherical Triangle* be equal to a *Semicircle*; then the two Angles at the *Baſe* ſhall be equal to two Right-angles; but if they be leſs, then the two Angles ſhall be leſs; but if greater, then ſhall the two Angles be greater than a *Semicircle*.

8. That the Summ of the Angles of a *Spherical Triangle*, is greater than two *Right-angles*.

9. *That every ſpherical Triangle* is either a *Right*, or *Oblique-angled Triangle*.

10. That the *Sines* of the Angles, are in proportion, unto the *Sines* of their oppoſite Sides; and the *Sines* of their oppoſite Sides, are in proportion unto the *Sines* of their oppoſite Angles.

11. That in a *Right-angled Spherical Triangle*, either of the *Oblique-angles*, is greater than the *Complement* of the other, but leſs than the *Difference* of the ſame *Complement* unto a *Semicircle*.

12. That a *Perpendicular* is part of the *Arch* of a *great Circle*, which, being let fall from any Angle of a *ſpherical Triangle*, cutteth the oppoſite Side of the *Triangle* at *Right-angles*, and ſo divideth

§. 4. divideth the *Triangle* into two *Right-angled Triangles*, and these two parts (either of the Sides or Angles) so divided must be sometimes added together, and sometimes substracted from each other, according as the *Perpendicular* falls within or without the Triangle.

PROP. I. Case 1.

A Side and an Angle adjacent thereunto being given, to find the other Side.

In the Triangle ABC, there is given the Side AB 27° 54′; and the Angle A 23° 30′, and the Side BC is required, to find which this is the *Analogy* or *Proportion.*

As the Radius or S. 90° 00′, ——— 10. 00000

To S. of cr. AB. 27, 54 ——— 9. 67018

Fig. 38. *So is* T. *V.* A, 23,30. ——— 9. 63830

To cr. BC. 11,30. ——— 9. 30848

PROP. II. Case 2.

A Side and an Angle adjacent thereunto being given, to find the other Oblique-angle.

In the Triangle ABC, there is given the Fig. 38. Side AB 27° 54′, and the Angle A 23° 30′, and the Angle at C is required, to find which say by this *Analogy* or *Proportion.*

As the Radius or S. 90° 00′,

To Sc. *of* cr. AB 27,54.

So

So is S. *V.* at A 23, 30, §. 4.
To Sc. *V.* at C 69, 22 required.

PROP. III. Case 3.

A Side and an Angle adjacent thereunto being given, to find the Hypothenuſe.

In the Triangle ABC, there is given the Side AB 27° 54′, and the Angle at A 23° 30′, and the *Hypothenuſe* AC, is required; which may be found by this *Analogy* or *Proportion*. *Fig.* 38.

As the Radius or S. 90° 00′,
To Sc. of *V.* at A 23, 30.
So is Tc. cr. AB, 27, 54.
To Tc. *Hypothenuſe* AC, 30, 00 required.

PROP. IV. Case 4.

A Side and an Angle oppoſite thereunto being given, to find the other Oblique-angle.

In the Triangle ABC, there is given the Side BC 11° 30′, and the Angle A 23° 30′, and the Angle C is required, to find which, ſay by this *Analogy* or *Proportion*. *Fig.* 38.

As Sc. cr. BC, 11° 30′,
To Radius or S. 90, 00.
So is Sc. *V.* at A, 23, 30,
To S. *V.* at C. 69, 22, as required.

PROP.

§. 4.

PROP. V. Case 5.

A Side and the oppoſite Angle given, to find the Hypothenuſe.

Fig. 38. In the Triangle ABC, there is given the ſide BC 11° 30′, and the Angle at A 23° 30′, and the *Hypothenuſe* AC, is required, which may be found by this *Analogy* or *Proportion.*

As S. *V.* at A 23° 30′,
To Radius or S. 90, 00.
So is Ser. BC 11. 30,
To S. *Hypothenuſe* AC 30, 00. as required.

PROP. VI. Case 6.

A ſide and the oppoſite Angle given, to find the other ſide.

In the Triangle ABC, there is given the ſide BC 11° 30′, and the Angle at A 23° 30′, and the ſide AB is required, to find which this is the *Analogy* or *Proportion.*

Fig. 38. *As Radius* or S. 90° 00′,
To Tc. of *V.* at A. 23. 30,
So is T. cr. BC 11, 30,
To S. of cr. AB 27. 54 as was required.

PROP. VII. Case 7.

The Hypothenuſe, and an Oblique Angle given, to find the ſide adjacent thereunto.

In the Triangle ABC, there is given the *Hypo-*

Hypothenuſe AC, 30° 00′, and the Angle A 23° 30′, and the ſide AB, is required, which is found by this *Analogy* or *Proportion.* §. 4.

As the Radius or S. 90° 00′, Fig. 38.
To Sc. *V.* at A, 23, 30.
So is T. *Hypoth.* AC, 30, 00,
To T. cr. AB, 27, 54, as was required.

PROP. VIII. Caſe 8.

The Hypothenuſe, and an Oblique-angle given, to find the oppoſite Side.

In the Triangle ABC, there is given the *Hypothenuſe* AC, 30° 00′, and the Angle at A 23° 30′, and the Side BC, is required, which is found by this *Analogy* or *Proportion.* Fig. 38.

As the Radius or S. 90° 00′,
To S. *Hypoth.* AC, 30, 00.
So is S. *V.* at A, 23, 30,
To the S. cr. BC, 11, 30. which was required.

PROP. IX. Caſe 9.

The Hypothenuſe, and an Oblique-angle given, to find the other Oblique-angle.

In the Triangle ABC, there is given the *Hypothenuſe* AC 30° 00′, and the Angle A, 23° 30′, now the Angle at C, is required, which may be found by this *Analogy* or *Proportion.*

As the Radius or S. 90° 00′,
To Sc. *Hypoth.* AC, 30, 00.
So is T. of *V.* at A, 23, 30, Fig. 38.
To Tc. of *V.* at C. 69, 22, as was required.

PROP.

§. 4.

PROP. X. Case 10.

The sides given, to find the Hypothenuse.

In the Triangle ABC, there is given the side AB 27° 54′, and the side BC 11° 30′, and the *Hypothenuse* AC is required, to find which say by this *Analogy* or *Proportion.*

Fig. 38. *As the Radius* or S. 90° 00′,
To Sc. cr. BC. 11, 30.
So is Sc. cr. AB 27, 54,
To Sc. *Hypothenuse* AC 30, 00. required.

PROP. XI. Case 11.

The sides given, to find an Angle.

In the Triangle ABC, there is given, the side AB 27° 54′, and the side BC 11° 30′, and the Angle at A, is required, which may be found by this *Analogy* or *Proportion.*

Fig. 38. *As the Radius* or S. 90° 00′,
To S. cr. AB. 27, 54.
So is Tc. cr. BC. 11, 30,
To Tc. of *V.* at A. 23. 30. as required.

PROP. XII. Case 12.

The Hypothenuse, and a side given, to find the other side.

Fig. 38. In the *Triangle* ABC, there is given, the *Hypothenuse* AC 30° 00′, and the side AB 27° 54′, and the side BC is required, which may be found

found by this *Analogy* or *Proportion.* §. 4.

As Sc. cr. AB. 27° 54′,
To Radius or S. 90 00.
So is Sc. *Hypothenuſe* AC. 30° 00′,
To Sc. cr. BC. 11° 30′ as required.

PROP. XIII. Caſe 13.

The Hypothenuſe, and a Side given, to find the contained Angle.

In the *Triangle* ABC, there is given the *Hypothenuſe* AC 30° 00′, and the ſide AB 27° 54′, and the Angle at A is required, which may be found by this *Analogy* or *Proportion.* Fig. 38.

As the Radius or S. 90° 00′,
To T. cr. AB. 27° 54′.
So is Tc. *Hypoth.* AC 30° 00′,
To Sc. of *V.* at A, 23° 30′, as required.

PROP. XIV. Caſe 14.

The Hypothenuſe, and a Side given, to find the oppoſite Angle.

In the *Triangle* ABC, there is given the *Hypothenuſe* AC 30° 00′, and the ſide AB 27° 54′, how the Angle C, is required, which may be found by this *Analogy* or *Proportion.* Fig. 38.

As the S. *Hypoth.* C, 30° 00′,
To Radius or S. 90° 00′.
So is S. *of* cr. AB, 27° 54′,
To S. of *V.* at C. 69 22, as required.

§. 4.

PROP. XV. Case 15.

The Oblique Angles given, to find either Side.

In the *Triangle* ABC, there is given the Angle A 23° 30′, and the Angle at C 69° 22′, and the side BC, is required, which may be found by this *Analogy* or *Proportion.*

Fig. 38.
As the S. of *V.* at C, 69° 22′,
To the Radius or S. 90° 00′.
So is the Sc. of *V.* at A, 23° 30′,
To the Sc. *of* cr. BC, 11° 30′, as required.

PROP. XVI. Case 16.

The Oblique-angles given, to find the Hypothenuse.

In the *Triangle* ABC, there is given the Angle A 23° 30′, the Angle C, 69° 22′, and the *Hypothenuse* AC, is required, which may be found by this *Analogy* or *Proportion.*

Fig. 38.
As the Radius or S. 90° 00′,
To Tc. of *V.* at C. 69°, 22′,
So is Tc. of *V.* at A, 23 30,
To Sc. *Hypoth.* AC, 30 00, as required.

SECT

SECT. V. §. 5.

Of Oblique-angled Spherical Triangles.

PROP. I. Case 1.

Two Sides, and an Angle opposite to one of them given, to find the other opposite Angle.

IN the *Triangle* ADE, there is given the Side AE, 70° 00′, the Side ED, 38° 30′, and the Angle A, 30° 28′, now the Angle at D, is required, to find which this is the *Analogy* or *Proportion.* *Fig.* 39.

As S. cr. DE, 38° 30′,
To S. *V.* at A, 30 28.
So is S. cr. AE, 70 00,
To S. *V.* at D, 130 03, required.

☞ *Note that in these Operations, for the more facility of the learner, I omit* Seconds, *which doth belong unto the* Angles, *&c.*

PROP. II. Case 2.

Two Angles and a Side opposite to one of them given, to find the Side opposite to the other.

In the *Triangle* ADE, there is given the Angle at D, 130° 03′, the Angle E, 31° 34′, and the Side AE, 70° 00′, now the Side AD, is required, which may be found by this *Analogy* or *Proportion.* *Fig.* 39.

§. 5. *As* S. *V.* at D, 130° 03′,
To S. cr. AE, 70 00.
So is S. *V.* at E, 31 34,
To S. cr. AD. 40 00, required.

PROP. III. Case 3.

Two Sides and an Angle included between them being known, to find the other Angles.

Fig. 39. In the *Triangle* ADE, there is given the Side AE, 70° 00′, the Side AD, 40° 00′, and the Angle A 30° 28′, Now the Angles D, and E, are required, which is thus found: take the *Sum* and *Difference* of the two *Sides*, and work as followeth, saying.

Side. AE, 70° 00′,
Side. AD, 40 00

Sum.	110 00	½ Z. 55° 00′.
Diff.	30 00	½ X. 15 00.
Angle.	A, 30 28	½ *V.* 15 14.

As S. ½ Z. cr^{s}. AE and AD, 55° 00′,
To S. ½ X. cr^{s}. AE and AD, 15 00.
So is Tc. ½ *V.* at A, 15 14,
To T. ½ X. *VV.* D and E. 49 14 30″.

☞ *And here observe that if the Sum of the two contained Sides exceed a* Semicircle, *then subſtract each ſide ſeverally from* 180°, *and proceed with thoſe* Complements, *as with the ſides given, the Operation produceth the* Complements *of the* Angles *ſought, unto a* Semicircle *or* 180 Degrees.

Again.

§. 5.

AGAIN.

As Sc. ½ Z. cr^{s}. AE and AD, 55° 00′,
To Sc. ½ X. cr^{s}. AE and AD, 15° 00′.
So is Tc. ½ *V*. at A, 15° 14′,
To T. ½ Z. *VV*. D and E, 80 48 30″.

This difference of the Angles unknown D and E, 49° 14′ 30″, being added unto the half Sum of the Angles 80° 48′ 30″, (unknown) produceth the Greater Angle D 130° 03′, and ſubſtracted from it, leaves the Leſſer Angle E, to wit 31° 34′.

PROP. IV. Caſe 4.

Two Angles, and their Interjacent ſide being known, to find the other ſides.

In the *Triangle* ADE, there is given the Angle at A 30° 28′, and the Angle at D 130° 03′, and their *Interjacent-ſide* AD 40° 00′, and the Sides DE and EA, are required: Which is thus found. *Fig.* 39.

Take the *Sum* and *Difference* of the two *Angles*, and work as followeth, ſaying.

☞ *And here obſerve that if the Sum of the two given Angles excede a* Semicircle *or* 180°, *ſubſtract them from a* Semicircle, *and proceed with the Reſidues, the Operation will produce each ſide's* Complement *to a* Semicircle, *or* 180 Degrees.

§. 3. *Angle.* D 130° 03′.
Fig. 39. *Angle* A, 30 28.

Sum.	160 31	½ Z. is 80° 15′ 30″
Diff.	99 35	½ X. is 49 47 30
Side. AD,	40 00	½ cr. is 20 00 00.

As S. ½ Z. *of VV.* A and D, 80° 15′ 30″,
To S. ½ X. *of VV.* A and D, 49 47 30.
So is T. ½ cr. AD, 20 00 00,
To T. ½ X. cr⁸. DE and EA, 15 45 00.

AGAIN Say.

As Sc. ½ Z. *of VV.* A and D, 80° 15′ 30″,
To Sc. ½ X. *of VV.* A and D, 49 47 30.
So is T. ½ cr. AD, 20 00 00,
To T. ½ cr⁸. Z. DE and AE. 54 15 00.

Add the half Difference of the Sides DE and AE, 15° 45′, unto half the Sum of the Sides DE and AE, 54° 15′. It produceth the greater Side, the Side AE 70° 00′, but if deducted from it, leaves the leſſer Side ED, which is 38° 30′, as was required.

PROP.

§. 5.

PROP. V. Case 5.

Two Sides and an Angle oppoſite to one of them given, to find the third ſide.

In the *Triangle* ADE, there is given the Side AE 70° 00′, the Side DE 38° 30′, and the Angle A 30° 28′, the Side AD is required. *Fig.* 39.

Firſt by *Caſe* 1. *Prop.* 1. I find the Angle at D to be 130° 03′, and then proceed thus

Firſt take the *Sum* and *Difference* of the two *Angles*; then alſo find the *Difference* of the two Sides given, and then work as followeth.

Angle D, 130° 03′,
Angle A, 30 28.

Sum	160 31	½Z. 80° 15′ 30″.
Differ.	99 35	½X. 49 47 30.

Side. AE	70 00.	
Side. ED	38 30.	
Diff.	31 30.	½X. 15° 45′.

Now ſay,

As S. ½X. *VV.* D and A, 49° 47′ 30″,
To S. ½Z. *VV.* D and A, 80 15 30.
So is T. ½X. cr^{s}. AE and ED, 15 45 00,
To T. ½ cr. AD. 20° 00′ 00″: which doubled giveth the Side AD, 40 00 00, as was required.

§. 5.

PROP. VI. Case 6.

Two Angles and a Side opposite to one of them given, to find the third Angle.

Fig. 39. In the *Triangle* ADE, there is given the Angle A 30° 28′, the Angle D 130° 03′, and his opposite Side AE 70° 00′, and 'tis required to find the Angle at E.

First by *Prop.* 2. *Case* 2. I find the Side DE, opposed to the Angle A; to be 38° 30′, then proceed thus.

First find the *Sum* and *Difference* of the *Sides*, Then find the *Difference* of the *Angles*.

Side.	DE 38° 30′,	
Side.	AE 70 00	
Sum.	108 30	½ Z. 54° 15′.
Differ.	31 30	½ X. 15 45.

Angle	D 130 03	
Angle	A 30 28	
Differ.	99 35	½ X. 49° 47′ 30″.

Now say,

As S. ½ X. cr^{s}. DE and AE 15° 45′,
To S. ½ Z. cr^{s}. EA and DE 54 15.
So is T. ½ X. *VV.* D and A 49 47 30″,
To Tc. ½ *V.* at E 15° 47′ 00″. which doubled giveth the Angle at E 31 34, as required.

PROP.

§. 5.

PROP. VII. Case 7.

Two Sides and an Angle opposite to one of them given, to find the Included Angle.

In the *Triangle* ADE, there is given the Side AE 70° 00′, the Side ED 38° 30′, and the Angle opposite thereunto at A 30° 28′, and the Angle E is required. *Fig.* 39.

First by *Prop.* 1. *Case* 1. I find the Angle D, oppofite to AE, to be 130° 03′, then proceed thus.

First find the *Difference* of the *Angles*, then find the *Sum* and *Difference* of the *Sides*.

Angle D 130° 03′
Angle A 30 28

Differ. 99 35 } ½ X. 49° 47′ 30″.

Side AE 70° 00′
Side ED 38 30

Sum 108 30 } ½ Z. 54° 15′.
Differ. 31 30 } ½ X. 15 45.

Now say,
As S. ½ X. cr^{s}. AE and ED 15° 45′,
To S ½ Z. cr^{s}. AE and ED 54 15.
So is T. ½ X. of *VV*. D and A 49 47 30″, *Fig.* 39.
To Tc. ½ *V* at E 15° 47′. Which doubled is the Angle at E 31° 34′, as was required.

PROP.

§. 5.

PROP. VIII. Case 8.

Two Angles and a Side opposite to one of them being known, to find the Interjacent Side.

In the *Triangle* ADE, there is given the Angle E 31° 34′, the Angle D 130° 03′, and his opposite Side AE 70° 00′, Now the Side ED is required.

First by *Prop.* 2. *Case* 2. I find AD opposed to E, to be 40° 00′, and then work thus.

Take the *Sum* and *Difference* of the *Angles*, then also find the *Difference* of the two *Sides*:

Fig. 39.

Angle D	130° 03′	
Angle E	31 34	
Sum	161 37	½ Z. 80° 48′ 30″
Differ.	98 29	½ X. 49° 14′ 30″

Side AD	40° 00′	
Side AE	70 00	
Differ.	30 00	½ X. 15° 00′

Now say,

As S. ½ X. *VV* D and E 49° 14′ 30″,
To S. ½ Z *VV* D and E 80 48 30.
So is T ½ X cr^{s}. AD and AE 15 00 00″,
To T. ½ cr^{s}. ED, 19° 15′ 00″, which being doubled is the Side ED 38° 30′, as required.

PROP.

§. 5.

PROP. IX. Case 9.

Two Sides and their Included Angle being known, to find the third Side.

In the *Triangle* APZ, there is given the Side ZP 38° 30′, the Side PA 70°, and the Angle P, let be 31° 34, and the Side AZ is required. *Fig.* 40.

The Resolution of this Case depends on the *Catholike propoſition* of the *Lord of Marchiſton*, by ſuppoſing the *Oblique-Triangle* to be divided (by a ſuppoſed *Perpendicular* falling either within or without the *Triangle*) into two *Rectangulars*.

Now in the *Triangle* AZP, let fall the *Perperpendicular* ZR; ſo is the *Triangle* AZP divided into two *Rectangulars* ARZ and ZRP. Now the Side AZ may be found at two *Operations* thus: ſay,

As the Radius or S. *of*	90°	00′
To Sc. *of the included* V, P.	31	34
So is T. *of the leſſer Side* PZ.	38	30
To T. *of a fourth Arch.*	34	08.

If the *contained Angle* be leſs than 90°, take this *fourth Arch* from the *greater Side*; but if it be greater than 90°, from its *Complement* unto 180°, the Remainder is the *Reſidual Arch*: Now again ſay,

As Sc. *of the fourth Arch.*	34°	08′
To Sc. *Reſidual Arch.*	35	52
So Sc. *of the leſſer Side* PZ.	38	30
To Sc. AZ *the Side required.*	40	00

☞ But

§. 5. ☞ But note that many times the *Perpendicu-*
Fig. 41. *lar* will fall without the *Triangle*, as it doth now within; in such case the Sides of the *Triangle* must be continued, so will there be two *Rectangulars*, the one included within the other: as in the *Triangle* HIK, the *Perpendicular* let fall is KM, falling on the Side HE, and so the two *Rectangulars* found thereby will be IMK, and KMH, and so by the directions in the former proposition find out the Side IK, if required to be found.

☞ *Note that if the Angles at the* Base *be both of one kind, that then the* Perpendicular *falls within the* Triangle: *if of diverse kinds, without the* Triangle.

PROP. X. Case 10.

Two Angles and their Interjacent Side known, to find the third Angle.

In the *Triangle* AZP, there is given the Side ZP 38° 30′, the Angle P 31° 34′, and the Angle Z 130° 03′, and the Angle at A is required.

First the *Oblique-Triangle* AZP, being reduced into two *Rectangulars* ARZ, and ZRP, by
Fig. 40. *Case* 9 *aforegoing*, I find the Angle RZP, to be 64° 19′, (in the *Triangle* ZRP.) which taken out of Angle AZP 130° 03′, leaves the Angle AZR 65° 44′: Now the Angle A is found by this *Analogy* or *Proportion.*

As S. *V.* PZR, 64° 19′,
To S. *V.* AZR 65 44,
So is Sc. *V.* at P 31 34,
To Sc. *V. at* A 30 28: which was required to be found out and known.

PROP.

PROP. XI. Case 11. §. 5.

Three Sides given, to find an Angle.

In the *Triangle* APZ, the Side AZ is 40° 00′, the Side ZP is 38° 30′, the Side AP is 70° 00′, and the Angle Z is required. To find which do thus.

Add the three Sides together, and from half their Sum, deduct the Side opposite, to the required Angle: and then proceed as you see in the Operation following. *Fig.* 40.

Side AP	70° 00′	*Co-Arith.*
Side AZ	40 00	0, 191933
Side ZP	38 30	0, 205850
Sum	148 30	Sines.
½ *Sum*	74 15	9, 983380
Side AP	70 00	
Rem.	04 15	8, 869868
Sum is		19, 251031 *Fig.* 40.

½ *Sum* is 65° 07′ 30″, the Sc. ½ *V.* at Z, 9, 625515 which doubled is 130° 03′ 12″; the Angle at Z required.

PROP.

§. 5.

PROP. XII. Case 12.

Three Angles given, to find a Side.

Fig. 40. In the *Triangle* AZP, the Angle A is 30° 28′ 11″, the Angle Z 130° 03′ 12″, the Angle P is 31° 34′ 26″, and the Side AZ, opposite to P, is required.

This *Case* is likewise performed as the former Case or Proposition, the Angles being converted into Sides, and the Sides into Angles, by taking the *Complement* of the greatest Angle unto 180°: see the work.

Angle E	31° 34′ 26″		*Co-Arith.*
Angle A	30 28 11	——	0, 294920
Comp. V. Z	49 56 49	——	0, 116084
Sum is	111 59 26		Sines
½ *Sum is*	55 59 43	——	9, 918549
Fig. 40. *Angle* P	31 34 26		
Differ.	24 25 17	——	9, 616417
Sum total		——	19, 945973
The ½ *Sum is* Sc. *of* 20° 00′ *half the Side* AZ,		——	9, 972986

which being doubled, gives the Side AZ 40° 00 required to be found out and known.

☞ But if the greater Side AP were required the Operation would produce the *Complement* thereof unto a *Semicircle* or 180°; therefo
subſtra

ſubſtract it from 180°, it leaves the remaining required Side ſought. §. 5.

Thus I have laid down all the *Caſes* of *Triangles*, both *Right-lined* and *Spherical*; either *Right*, or *Oblique-angled*; I might hereunto have annexed many Varieties unto each *Caſe*, and ſome fundamental *Axioms*, which ſomewhat more would have Illuſtrated and Demonſtrated thoſe *Caſes*, and *Proportions*; but becauſe of the ſmallneſs of this *Treatiſe*, which is intended more for *Practice* than *Theory*, I have for brevity ſake omitted them, and refer you for thoſe things to larger Authors, who have largely diſcourſed thereon to good purpoſe.

CHAP.

CHAP. VI.

Of ASTRONOMY.

Defin. ASTRONOMY *is an Art Mathematical, which measureth the distinct course of Times, Days, Years,* &c. *It sheweth the Distance, Magnitude, Natural Motions, Appearances and Passions, proper unto the Planets, and fixed Stars, for any time past, present and to come; by this we are certified of the Distance of the starry Sky, and of each Planet, from the Center of the Earth, and the Magnitude of any fixed Star or Planet, in respect of the Earth's Magnitude.*

§. 1. SECT. I.

Of Astronomical Definitions.

Defin. 1. A *Sphere or Globe* is a solid Body, containing onely one *Superficies*, in whose middle there is a point (called the *Center*,

Center,) from which all right or ſtreight lines drawn unto the *Circumference* or *Superficies*, are Equal. §. 1.

2. *The Poles* of the World, are two fixed points in the *Heavens Diametrically* oppoſite the one to the other, the one called the *Artick* or *North-Pole*; noted in the *Scheme* by P. The other is called the *Antartick*, or *South-Pole*; as S. and is not to be ſeen of us, being in the lower *Hemiſphere*. *Fig.* 42.

3. *The Axis* of the *World*, is an imaginary line drawn from the *North-Pole*, through the *Center* of the *Earth*, unto the *South-Pole*; about which the *Diurnal* motion is performed, from the *Eaſt* to the *Weſt*; as the line PS. *Fig.* 42.

4. *The Meridians* are great *Circles*; concurring and interſecting one another, in the *Poles* of the *World*, as PES, and Pc S. *Fig.* 42.

5. The *Equinoctial*, or *Equator*, is a great Circle, 90 deg. diſtant from the *Poles* of the *World*; cutting the *Meridians* at *Right-angles*, and divideth the *World* into two Equal parts, called the *Northern*, and *Southern Hemiſpheres*; as E ♎ Q. in *Scheme* 42. *Fig.* 42.

6. *The Ecliptick* is a great Circle, croſſing the *Equinoctial*, in the two oppoſite points *Aries* and *Libra*, and maketh an Angle therewith (called, its *Obliquity*) of 23° 30′; repreſented by ♋♎♑. This *Circle* is divided into 12 *Signes*, each containing 30° 00′: *As Aries* ♈, *Taurus* ♉, *Gemini* ♊, *Cancer* ♋; *Leo* ♌, *Virgo* ♍, (which are called *Northern Signes*) *Libra* ♎; *Scorpio* ♏, *Sagitarius* ♐; *Capricornus* ♑, *Aquarius* ♒, and *Piſces* ♓; theſe are called *Southern Signes*. *Fig.* 43.

§. 1. 7. The *Zodiack* is a *Zone* or *Girdle*, having 8 deg. of *Latitude* on either side the *Ecliptick*, in which space the *Planets* make their revolution. This *Circle* is a Circle which regulates the *Years*, *Months*, and *Seasons*, * and is distinguished in the *Scheme* by the 12 *Signes*.

Fig. 42.

* *Which is by the Greeks called* Zodiak ☉, i. e. *bring Life*; *because the life of all Creatures depend on the cause of that Circle, for the Sun ascending in it and moving towards us, brings the Generation of things, and in descending the Corruption of all things sensible, and insensible, which are below the concavity of the Moon*, &c.

8. The *Colures* are two *Meridians*, dividing the *Ecliptick*, and the *Equinoctial*, into four equal parts; one of which passeth by the *Equinoctial* points *Aries*, and *Libra*, and is called the *Equinoctial Colure*, as P ♈ S. The other by the beginning of *Cancer*, and *Capricorn*, and is called the *Solstitial Colure*, as P ♋, S ♑.

Fig. 42.

9. The *Poles* of the *Ecliptick* are two points, 23° 30′ distant from the *Poles* of the *World*, as I and K

Fig. 42.

10. The *Tropicks* are two *small Circles*, *Parallel* unto the *Equinoctial*, and distant therefrom 23° 30′, limiting the *Sun's greatest declination*. The *Northern Tropick* passeth by the beginning of *Cancer*, and is therefore called the *Tropick of Cancer*, as ♋ a D. The *Southern Tropick* passeth by the beginning of *Capricorn*, and is therefore called the *Tropick* of *Capricorn*; as B b ♑.

Fig. 42.

11. The *Polar Circles*, are two small Circles *parrallel* to the *Equinoctial*, and distant therefrom 66° 30′; and from the *Poles* of the *World*

23°

23°. 30′. That which is *adjacent* unto the *North Pole*, is called the *Artick Circle*, as G d I. and the other the *Antartick Circle*, as K d M. §. 1. *Fig.* 42.

12. The *Zenith*, and the *Nadir*, are two points, *Diametrically* opposite the one to the other: the *Zenith* is the *Vertical point*, or the point over our heads, as Z, The *Nadir*, is opposite thereto as the point N.

13. The *Azimuths* or *Vertical Circles* are great Circles of the *Sphere*, concurring and intersecting each other, in the *Zenith*, and *Nadir*, as Z f N.

14 The *Horizon*, is a great Circle, 90 deg. distant from the *Zenith*, and *Nadir*; cutting all the *Azimuths*, at Rightangles, and dividing the World into two equal parts, the upper and *visible Hemisphere*, and the lower and *invisible Hemisphere*, represented by H = R. *Fig.* 42.

15. The *Meridian* of a *Place*, is that *Meridian*, which passeth by the *Zenith*, and *Nadir*, of the place as P Z S N. *Fig.* 42.

16. The *Almicanthars*, or *Parallels of Altitude*, are small Circles, parrallel unto the *Horizon*, imagined to pass through every degree and minute of the *Meridian*, between the *Zenith*, and *Horizon*, as B a F.

17. *Parallels of Latitude*, or *Declination*, are small Circles parallel unto the *Equinoctial*; they are called *Parallels* of *Latitude*, in respect to any place on the *Earth*, and *Parallels* of *Declination*, in respect of the *Sun*, or *Stars*, in the *Heavens*. *Fig.* 42.

18. The *Latitude of a place*, is the height of the *Pole* above the *Horizon*; or the distance between the *Zenith* and the *Equinoctial*.

§. 1. 19. The *Latitude of a Star*, is the *Arch of* a *Circle*, contained betwixt the *Center of* a *Star*, and the *Ecliptick line*: this Circle making *Right-angles*, with the *Ecliptick*, is accounted either *Northward* or *Southward*; according to the Scituation of the *Star*.

20. *Longitude* on *Earth* is measured by an *Arch* of the *Equinoctial*, contained between the *Primary Meridian*, (or *Meridian* of that place where *Longitude* is assigned to begin) and the *Meridian* of any other place, counted always *Easterly*.

21. The *Longitude* of a *Star*, is that part of the *Ecliptick*, which is contained between the *Star's place* in the *Ecliptick*, and the beginning of *Aries*, counting them according unto the succession of *Sines*.

22. The *Altitude* of the *Sun* or *Stars*, is the *Arch* of an *Azimuth*, contained betwixt the *Center* of the *Sun*, or *Star*, and the *Horizon*.

23. *Ascension* is the rising of any *Star*, or part of the *Equinoctial*, to any degree above the *Horizon*; and *Descension* is the setting of it.

24. *Right Ascension*, is the number of *Degrees* and *Minutes* of the *Equinoctial*; (i. e. from the beginning of *Aries*) which cometh unto the *Meridian*, with the *Sun* or *Stars*; or with any portion of the *Ecliptick*.

25. *Oblique-Ascension*, is an *Arch* of the *Equinoctial*, between the beginning of *Aries*, and that part of the *Equinoctial* which riseth with the *Center* of a *Star*; or with any *portion* of the *Ecliptick* in an *Oblique Sphere*: and *Oblique Descention*, is that part of the *Equinoctial*, that setteth therewith.

26. The

26. The *Aſcentional difference*, is an *Arch* of the *Equinoctial*, being the difference betwixt the *Right* and *Oblique-Aſcenſion*. §. 1.

27. The *Amplitude*, of the *Sun* or *Stars*, is the diſtance of the riſing or ſetting thereof, from the *Eaſt* or *Weſt* point of the *Horizon*. *Fig.* 43.

28. The *Parallax*, is the difference between the *true* and *apparent place* of the *Sun* or *Star*; ſo the *true place* in reſpect of *Altitude*, is in the line ACE, or ADG, the *Sun* or *Star* being at C, or D, and the *apparent place* in the Line BCF, and BDH, ſo likewiſe the Angles of the *Parallax* are ACB, or ECF; and ADB, or GDB: alſo in the ſaid *Scheme*, ABK repreſenteth a *Quadrent* (of the *Globe* or *Earth*,) on the *Earth's Superficies*: A the *Center* of the *Earth*, and B any point of the *Earth's Surface*. *Fig.* 43.

29. The *Refraction* of a *Star*, is cauſed by the *Atmoſphere*, or *Vapourous* thickneſs of the *Air* near the *Earth's Superficies*, whereby the *Sun* and *Stars* ſeem always to riſe ſooner, and and ſet later than really they do.

---

§. 2.

SECT. II.

Of Astronomical Propositions.

PROP. I.

The Distance of the Sun from the next Equinoctial point (either Aries *or* Libra*) being known, to find his Declination.*

THE *Analogy* or *Proportion.*

As Radius or S. 90°,
To S. *of the Sun's distance from the next Equinoctial point,*
So is S. *of the Sun's greatest Declination,*
To the S. *of the Sun's present Declination sought.*

PROP. II.

The Sun's place given, to find his Right-Ascension.

This is the *Analogy* or *Proportion.*

As Radius or S. 90°,
To T. *of the Sun's Longitude from the next Equinoctial point,*
So is the Sc. *of his greatest Declination,*
To T. *of his Right-Ascension from the next Equinoctial point.*

PROP.

§. 2.

PROP. III.

To find the Sun's place or longitude from Aries, *his Declination being given.*

This is the *Analogy* or *Proportion.*
As S. *of the Suns greateſt Declination,*
To Radius or S. 90° 00′,
So is S. *of his preſent Declination,*
To S. *of the Suns Place*
or Longitude from Aries *.

* *If the* Sun's Declination *be* North, *and increaſing, this Proportion finds the* Sun's *diſtance from* ♈; *but if decreaſing from* ♎ *in the northern* Sines. *But if the* Sun's Declination *be* South, *and increaſing from* ♎; *if decreaſing from* ♈, *among the* Southern Sines.

PROP. IV.

By knowing the Suns Declination, to find his Right Aſcenſion.

This is the *Analogy* or *Proportion.*
As Radius or S. 90°,
To Tc. *of the Suns greateſt Declination,*
So is T. *of the Declination given,*
To S. *of the Suns right*
Aſcenſion required †.

† *From the next* Equinoctial *point either* ♈, *or* ♎.

§. 2.

SECT. II.

Of Astronomical Propositions.

PROP. I.

The Distance of the Sun from the next Equinoctial point (either Aries *or* Libra*) being known, to find his Declination.*

THE *Analogy* or *Proportion.*

As Radius or S. 90°,
To S. *of the Sun's distance from the next Equinoctial point,*
So is S. *of the Sun's greatest Declination,*
To the S. *of the Sun's present Declination sought.*

PROP. II.

The Sun's place given, to find his Right-Ascension.

This is the *Analogy* or *Proportion.*

As Radius or S. 90°,
To T. *of the Sun's Longitude from the next Equinoctial point,*
So is the Sc. *of his greatest Declination,*
To T. *of his Right-Ascension from the next Equinoctial point.*

PROP.

§. 2.

PROP. III.

To find the Sun's place or longitude from Aries, *his Declination being given.*

This is the *Analogy* or *Proportion.*
As S. *of the Suns greateſt Declination,*
To Radius or S. 90° 00′,
So is S. *of his preſent Declination,*
To S. *of the Suns Place*
or Longitude from Aries *.

* *If the* Sun's Declination *be* North, *and increaſing, this Proportion finds the* Sun's *diſtance from* ♈; *but if decreaſing from* ♎ *in the northern* Sines. *But if the* Sun's Declination *be* South, *and increaſing from* ♎; *if decreaſing from* ♈, *among the* Southern Sines.

PROP. IV.

By knowing the Suns Declination, to find his Right Aſcenſion.

This is the *Analogy* or *Proportion.*
As Radius or S. 90°,
To Tc. *of the Suns greateſt Declination,*
So is T. *of the Declination given,*
To S. *of the Suns right*
Aſcenſion required †.

† *From the next* Equinoctial *point either* ♈, *or* ♎.

§. 2.

PROP. V.

By knowing the Latitude of a Place, and the Suns Declination, to find the Ascensional Difference.

This is the *Analogy* or *Proportion.*
As Radius or S. 90°,
To Tc. *of the Latitude given,*
So is T. *of the Suns Declination given,*
To the S. *of the Ascensional difference* required.

☞ Note that if you reduce the degrees, &c. of the *Ascensional difference* into hours, it will shew you how much the *Sun* riseth, or setteth before, or after six a Clock, in that Latitude.

PROP. VI.

To find the Suns Oblique Ascension or Descension.

First find the *Ascensional Difference* by the 5*th* Proposition, and his *Right-ascension* by the fourth: Now if the *Suns Declination* be Northerly, deduct the *Ascentional Difference* out of his *Right Ascension*, from the beginning of ♈, (for the six Northern Signs ♈ ♉ ♊ ♋ ♌ ♍) it leaves the *Oblique Ascension*; and added unto the *Right-ascension*, giveth the *Oblique-descension.*

But if the *Suns Declination* be *Southerly*, the *Ascentional Difference*, added to the *Right-ascension*, (for the six Southern Signs ♎ ♏ ♐ ♑ ♒ ♓) giveth the *Right-ascension*, and substracted therefrom leaves the *Oblique-descension.*

PROP.

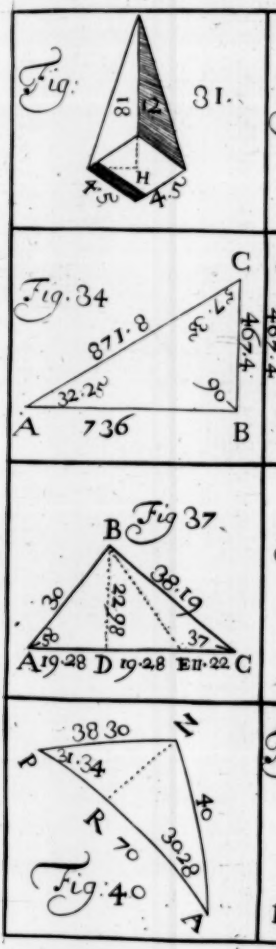


Fig. 31.
18
12
H
4.5
4.5
Fig. 34
C
871.8
407.4
32.25
90
A
736
B
Fig 37
B
38.19
30
22.98
58
37
A 19.28 D 19.28 E 11.22 C
38 30
N
P
21.34
40
R
70
30.28
A
Fig. 40

Fig: 32.

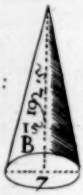


Fig: 33.

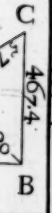


Fig: 35.

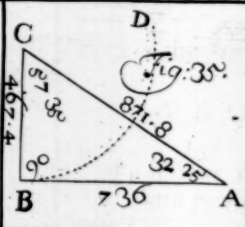
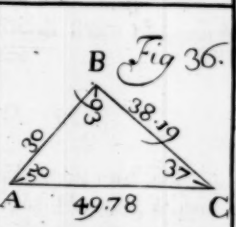


Fig 36.



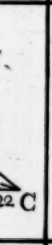
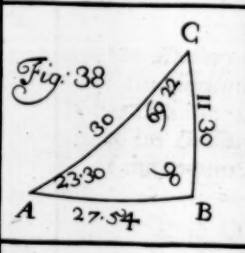


Fig: 38



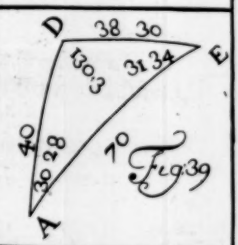


Fig 39

Fig: 41

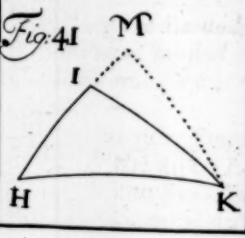
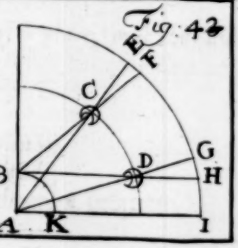


Fig: 42



§. 2.

PROP. VII.

By knowing the Suns Declination, and the Latitude of a Place, to find the Suns Amplitude.

This is the *Analogy* or *Proportion.*
As Sc. *of the Latitude,*
To the Radius or S. 90°.
So is the S. *of the Suns Declination,*
To the S. *of the Amplitude* from the *Eaſt* or *Weſt* Points of the *Horizon.*

PROP. VIII.

By knowing the Suns Declination and Amplitude, from the North part of the Horizon, to find the Latitude.

This is the *Analogy* or *Proportion.*
As Sc. *of the Amplitude* from the *North,*
To Radius or S. 90° 00′
So is S. of his *Declination* given,
To Sc. of the required *Latitude.*

PROP. IX.

By knowing the Latitude of a place, and the Sun's Declination, to find at what time the Sun will be on the true Eaſt or Weſt Points.

The *Analogy or Proportion* is.
As T. of the given *Latitude,*
To. T. of the *Sun's Declination* propounded,
So is Radius or S. 90° 00′,
To Sc. of the *Hour* from *Noon.* PROP.

§. 2.

PROP. VII.

By knowing the Suns Declination, and the Latitude of a Place, to find the Suns Amplitude.

This is the *Analogy* or *Proportion.*
As Sc. *of the Latitude,*
To the Radius or S. 90°.
So is the S. *of the Suns Declination,*
To the S. *of the Amplitude* from the *Eaſt* or *Weſt* Points of the *Horizon.*

PROP. VIII.

By knowing the Suns Declination and Amplitude, from the North part of the Horizon, to find the Latitude.

This is the *Analogy* or *Proportion.*
As Sc. *of the Amplitude* from the *North,*
To Radius or S. 90° 00′
So is S. of his *Declination* given,
To Sc. of the required *Latitude.*

PROP. IX.

By knowing the Latitude of a place, and the Sun's Declination, to find at what time the Sun will be on the true Eaſt or Weſt Points.

The *Analogy or Proportion* is.
As T. of the given *Latitude,*
To. T. of the *Sun's Declination* propounded,
So is Radius or S. 90° 00′,
To Sc. of the *Hour* from *Noon.* PROP.

§. 2.

PROP. X.

By knowing the Sun's Declination, and Latitude of a place, to find his Altitude at six a Clock.

This is the *Analogy* or *Proportion.*
As Radius or S. 90° 00′,
To S. of the *Sun's Declination,*
So is S. of the *Latitude of the place,*
To S. of the *Sun's Altitude* at six a Clock.

PROP. XI.

By knowing the Latitude of a place, and the Sun's Declination, to find the Azimuth at six.

This is the *Analogy* or *Proportion.*
As Radius or S. 90° 00′,
To the T. of the *Sun's Declination,*
So is Sc. of the *Latitude of the place,*
To the T. of the *Azimuth* sought.

PROP. XII.

By knowing the Latitude of a place, and the Sun's Declination, to find the Sun's Altitude when he is on the true East or West points.

This is the *Analogy* or *Proportion.*
As S. of *the Latitude,*
To the Radius or S. 90° 00′,
So is the S. of the *Declination,*
To the S. of the *Sun's Altitude* being due *East* or *West.*

PROP.

§. 2.

PROP. XIII.

To find the Sun's Altitude at any time of the day.

The *Analogy* or *Proportion* is.
As Radius or S. 90° 00′,
To Tc. of the *Poles height*,
So is S. of the *Sun's Diſtance*,
From the Hour of Six,
To the T. of an *Arch*: which being ſubſtracted from the *Sun's Diſtance* from the *Pole*; ſay,
As Sc. of the *Arch found*,
To Sc. of the *remaining Arch* of the *Sun's Diſtance* from the *Pole*,
So is S. of the *Poles height*,
To the S. of the *Sun's Altitude* at the Hour required.

PROP. XIV.

By knowing the Latitude of a Place, with the Sun's Declination, and Altitude, to find the Hour of the Day.

To ſolve this Concluſion do thus: get the Sum of the *Complements* of the *Latitude*, *Declination* and *Altitude* given *, Then find the Difference betwixt their half Sum, and the *Complement* of the *Altitude*; then ſay,

* *As in Caſe* 11 *of Oblique Spherical Triangles.*

As Radius or S. 90° 00′,
To Sc. of the *Sun's Altitude*,
So is Sc. of the *Latitude* of the Place,

To

§. 2. *To a fourth Sine*: then again ſay,
As the fourth S.
To the S. of ½ Z. of the *Lat. Declin.* and *Alt.*
So is the S. of X. of the *Altitude* to the ½ Z,
To a fifth S. unto which *Sine*, if you add the *Radius* or 90° 00′, half that Sum ſhall be the *Sine* of an *Arch*, whoſe double *Complement* is the Hour from the *Meridian*.

PROP. XV.

To find the Time of the Sun's Riſing or Setting, and conſequently the Length of the Day or Night.

To reſolve this *Concluſion*, firſt by prop. the 5. find the *Aſcenſional Difference*, which reduced into *Hours*, and *Minutes* of Time, by allowing for every 15 *Deg.* one *Hour*, and for every *Deg.* leſs than 15°, 4′, of Time, and for every 15 *Min.* one *Minute* of *Time*.

Secondly, If the *Sun's Declination* be Northerly, the *Aſcentional Difference* added unto 6 Hours, gives the Time of *Sun-ſetting*, and ſubſtracted therefrom, leaves the Time of *Sun-Riſing*: On the contrary, if the *Sun's Declination* be *Southerly*, the *Aſcentional Difference* added unto 6 Hours, gives the Time of *Sun-Riſing*, and deducted therefrom, the Time of *Sun-ſetting*.

Thirdly, If you double the Time of *Sun-Riſing*, it gives you the length of the *Night*; and the Time of *Sun-ſetting*, the length of the *Day*.

PROP.

§. 2.

PROP. XVI.

The Sun's Declination, Altitude and Azimuth known, to find the Hour of the Day.

The *Analogy* or *Proportion* is.
As the Sc. of the *Sun's Declination,*
To the S. of the *Azimuth,*
So is the Sc. of the *Altitude,*
To the S. of the Hour from *Noon:* which converted into Time, will ſhew the Hour of the Day.

PROP. XVII.

By knowing the Sun's Declination, Altitude, and Hour from Noon, to find the Azimuth.

The *Analogy* or *Proportion* is.
As Sc. of the *Sun's Altitude,*
To S. of the *Hour from Noon,*
So is Sc. of the *Sun's Declination,*
To the S. of the *Azimuth,* required.

PROP. XVIII.

By knowing the Latitude of a place, the Altitude of the Sun, and the Hour from Noon, to find the Angle of the Sun's Poſition.

This is the *Analogy* or *Proportion.*
As Sc. of the *Sun's Altitude,*
To S. of the *Hour from Noon,*
So is Sc. of the *Latitude,*

To

§. 2. *To* S. of the *V.* of the *Sun's Position*, at the time of the *Question.*

PROP. XIX.

By knowing the Sun's Altitude, Declination, and Azimuth; to find the Latitude.

The *Analogy* or *Proportion* is:
As S. of the *Sun's Azimuth*;
To S. of his *Distance from* the *North-pole*,
So is S. of *V* of the *Sun's Position*,
To Sc. of the *Latitude* required.

PROP. XX.

To find the length of the Crepusculum, or Twilight.

The Crepusculum or *Twilight*, is nothing else but the *Refraction* of the *Sun's Beams* in the *Density* of the *Air*. *Nonnius* found the length of the *Crepusculum* (by his many strict observations *) to continue from the time of the *Sun's* passing below the *Horizon* of a place, untill the *Sun* had run below the said *Horizon* 18° 00', and then followed the shutting in of the *Twilight*, and untill the *Sun* was departed

Which the Learned *Pet.*

* *Watched the Time after* Sun-setting *when the* Twilight *in the* West *was shut in, so that no more* Twilight *than in any other part of the* Skie *near the* Horizon *appeared there: then by one of the known* fixed Stars, *having found the true* Hour *of the* Night, *he*

departed ſo low the *Twilight* continued.---To find which obſerve this *Analogy* or *Proportion*. §. 2.

found the length of the Twilight, *to be as in the rule is mentioned.*

As Radius or S. 90°,
To Sc. of the *Sun's Declination*,
So is Sc. of the *Poles-height*,
To a fourth Sine: which keep.

Then out of the *Sun's Diſtance* from the *South-Pole*, ſubduct the *Complement* of the *Pole*; and of that remains and the degrees 62, being added to it, their *Sum* and *Difference* found, ſay again.

As the fourth Sine found,
To S. ½ Z. of the *remainder* and 62° 00′,
So is S. ½ X. of the *remainder* and 62° 00′,
To a Number, which being multiplyed by the *Radius* is equal unto the *Quadrat* of the *Sine* of the ½ *Angle* of the *Sun's Diſtance* at the Ending of the *Twilight*, from *Noon* next enſuing.

Then from the *Sun* of the whole *Angle* converted into *Hours*, ſubſtract the *Hour* of the *Sun's ſetting* *, it gives you the length of the *Crepuſculum*, or *Twilight*.

* *Or* ½ *Diurnal Arch.*

But the *Sun* being in the *Winter Tropick*, makes the *Twilight* longeſt of any *Twilight*, the whole *Winter* half year: Now in a certain *Parallel*, betwixt that *Tropick*, and the *Equinoctial* is the ſhorteſt *Crepuſculum*: the *Declination* of which *Parallel*, is thus found.

To find the length of the leaſt Crepuſculum *or* Twilight.

As the Tc. of the *Pole*,
To the S of the *Pole*,
So is the T. of 99° 00′,

To

§. 2. *To* S. of the *Declination* of the *Parallel*, in which the *Sun* maketh the ſhorteſt *Crepuſculum* of the Year.

But before the *Crepuſculum* come to be ſhorteſt, there is another *Parallel*, in which the *Crepuſculum* is equal to that of the *Equinoctial*: the *Declination* of which is found thus.

As the Radius or S. 90° 00′,
To S. of the *Poles Elevation* or *Altitude*,
So is S. of 18° 00′,
To S. of the *Declination* of the *Parallel*, in which the *Sun* maketh the *Crepuſculum* equal to that in the *Equinoctial*.

PROP. XXI.

To find the Quantity of the Angles, which the Circles of the 12 *Houſes make with the Meridian.*

This is the *Analogy* or *Proportion*.
As the Radius or S. 90°,
To T. *of* 60°: *for the* 11th, 9th, 5th and 3d *Houſe*, Or to the T. 30° *for the* 12th, 8th, 6th, and 2d *Houſe*,
So is the Sc. of the *Pole*,
To the Tc. of any *Houſe* with the *Meridian*.

PROP.

PROP. XXII. §. 2.

To find the Right Aſcenſion of the Point in the Equinoctial: and alſo the Point in the Ecliptick, called Medium Cæli or *Cor Cæli.*

Firſt, To find the *Right Aſcenſion* of the Point of the *Equinoctial*, called *Medium Cæli, vel Cor Cæli*, find out the *Sun's Right Aſcenſion*, by prop. 2. Then reduce the whole Time from Noon laſt paſt into *degrees*, which add unto the *right Aſcenſion* of the *Sun*, ſo ſhall their *Aggregat*, be the *right Aſcenſion* of the point, which in the *Equinoctial*, is called *Medium Cæli, vel Cor Cæli*, required to be found.

Secondly, By the 2 propoſitions aforegoing, you may find the *right Aſcenſion* of the point in the *Ecliptick Culminant* in the *Meridian*, called *Medium Cæli* vel *Cor Cæli*, which is the *Cuſpis of the tenth Houſe*: and his *Declination* by prop. the firſt.

PROP. XXIII.

To find the Angle of the Ecliptick with the Meridian.

The *Analogy* or *Proportion* is.

As the Radius or S. 90°,

To S. of the *Sun's Greateſt Declination*,

So is Sc. of the *Sun's right Aſcenſion*, from the next *Equinoctial point*,

To Sc. of the *∠*. of the *Ecliptick*, with the *Meridian.*

§. 2.

PROP. XXIV.

To find the Angle of the Ecliptick with the Horizon.

The *Analogy* or *Proportion* is.
As Radius or S. 90°,
To Sc. of the *Altitude* of *Cor Cœli*,
So is S. of the *V. Ecliptick* with the *Meridian*,
To Sc. of the *V.* of the *Ecliptick* and *Horizon* sought.

PROP. XXV.

To find the Amplitude Ortive of the Ascendent, or Horoscopus.

This is the *Analogy* or *Proportion.*
As Radius or S. 90°,
To S. of *Altitude* of *Med. Cœli*,
So is T. of *V. Ecliptick* with the *Meridian*,
To Tc. of the *Amplitude Ortive of the Ascendent, or the distance of the* Azimuth *from the Meridian.*

PROP. XXVI.

To find the Ascendent degree of the Ecliptick, or the Cuspis of the first House.

The *Amplitude Ortive* of the *Ascendent*, is equal to the Distance of the *Azimuth* of 90°, from the *Meridian*, wherefore the *Cuspis* of the first

firſt *Houſe*, or *Aſcendent Degree* of the *Ecliptick*, may be found thus. §. 2.

As Radius or S. 90°,
To Sc. of the *V. Ecliptick* with the *Meridian*,
So is Tc. of the *Altitude* of *Med. Cœli*,
To T. of the Diſtance of *Med. Cœli*, from the *Aſcendent Degrees.*

PROP. XXVII.

To find the Diſtance of the Cuſpis of any Houſe, from Med. Cœli.

This is the *Analogy* or *Proportion.*
As Sc. of the remaining part of *V.* of the *Ecliptick* with the *Meridian*, (found by prop. 28.)
To Sc of the former part of the *V*,
So is T. of the *Altitude* of *Med. Cœli*,
To T. of the Diſtance of the *Cuſpis* of that *Houſe* ſought, from *Med. Cœli.*

PROP. XXVIII.

To find the parts of the Angle of the Ecliptick with the Meridian, cut with an Arch perpendicular to the Circle of any of the Houſes.

The *Analogy* or *Proportion* is:
As Radius or S. 90°,
To Sc. *Altitude* of *Med. Cœli*,
So is T. of the Circle of any Houſe with the *Meridian*,
To Tc. of that part of that Angle which is next the *Meridian*:
Then ſubſtract that part found, out of the whole Angle, for the remaining or latter part

§. 2.

PROP. XXIX.

To find the Pole's Altitude, above any of the Circles of the Houses.

The *Analogy* or *Proportion* is.

As the Radius or S. 90°,

To S. of *V.* of the Circle of the House with the *Meridian*: (found by the 21 prop.)

So is the S. of the *Poles Elevation*, above the *Horizon* of the Place,

To S. of the *Altitude* of the *Pole*, above the *Circle of Position.*

PROP. XXX.

By knowing the Latitude and Longitude of any fixed Star, to find his Right Ascension and Declination.

The *Analogy* or *Proportion* is.

1. *As Radius* or S. 90°,

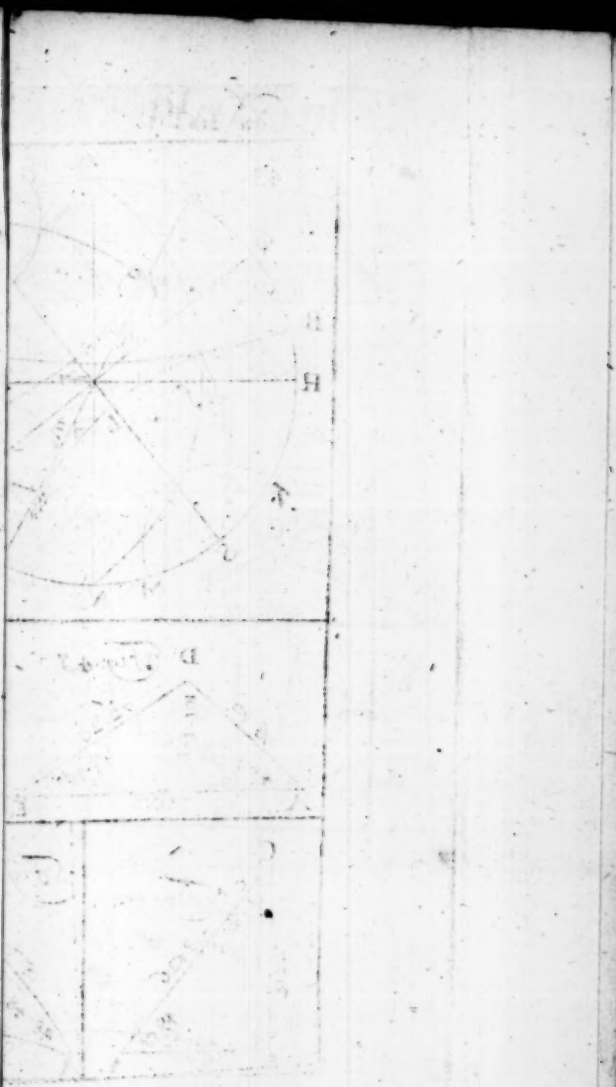
To S. of the Stars *Longitude* from the next *Equinoctial point*,

So is Tc. of the *Stars Latitude*,

To T. of a *fourth Arch.*

Which compared with the *Arch of Distance* betwixt the *Poles of the World* and the *Ecliptick* 23°, 30′; And if the *Latitude* and *Longitude* of the *Star* be both of one Dignity, *i. e.* when the Star hath *North Latitude* in the six *Northern Signs*, ♈, ♉, ♊, ♋, ♌, ♍, or *South Latitude* in the six *Southern Signs*, ♎, ♏, ♐, ♑, ♒, ♓: Then shall the difference between this *found Arch*, and the

Di-



§. 2.

Page 216

Fig 43.

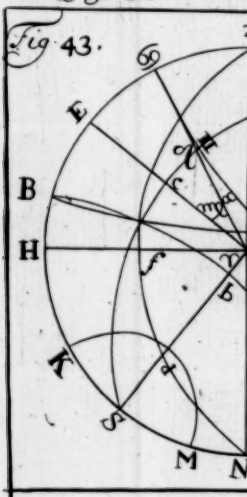


Fig:

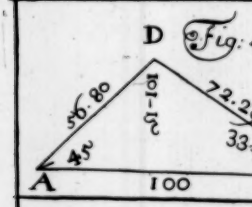


Fig: 50

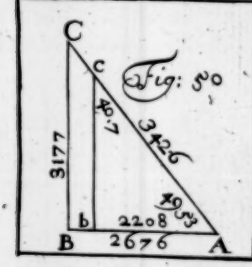
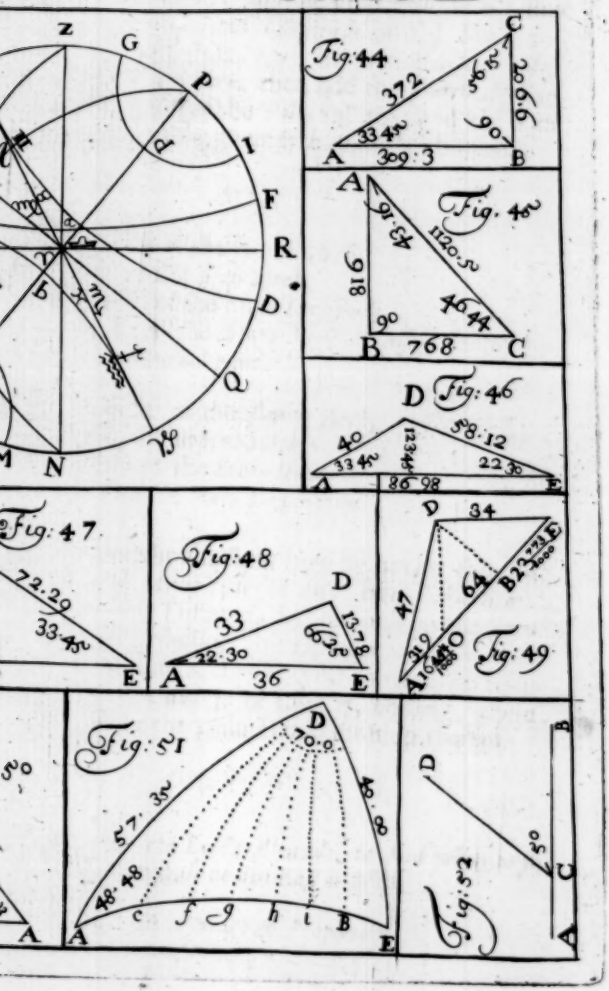


Plate III


Z
G
P
I
F
R
D
Q
N
M
Fig: 44
C
372
56.15
206.6
33.45
90
A
309:3
B
Fig. 45
A
43.16
1120.5
918
46.44
90
B
768
C
Fig: 46
D
40
58.12
123.45
33.45
22.30
A
86.98
E
Fig: 47
72.29
33.45
E
Fig: 48
D
33
13.78
66.35
22.30
A
36
E
D
34
47
64
B
22.773
4000
E
319
A
16.451
1000
O
Fig: 49
50
A
Fig: 51
D
70.0
57.35
40.00
48.48
c
f
g
h
i
B
A
E
Fig: 52
D
B
50
C
A

Distance of the *Poles* be your *fifth Arch*: But if the *Latitude* and *Longitude* of the *Star* be of contrary qualities, *i. e* the one *Northern*, and the other *Southern*, then add this *fourth Arch* to the Distance of the *Poles* 23° 30′, and the Sum thereof shall be your *fifth Arch*; with which, §. 2.

AGAIN, say.

2. *As* S. of the *fourth Arch*,
To S. of the *fifth Arch*,
So is T. of the *Stars Longitude*,
To T. of the *Stars Right-ascension* from the next *Equinoctial point*.

3. *As* Sc. of the *fourth Arch*,
To Sc. of the *fifth Arch*,
So is S of the *Stars Latitude*,
To S. of the *Stars Declination*.

☞ I might also shew how by having the *Latitude* and *Longitude* of any two *fixed Stars*, to find their Distance: but because 'tis the very same with finding the Distance of any two Places on Earth, I refer you to the Directions of *Prop* 1, 2 *and* 3. of *Chap.* 7, ensuing, where you will see the plain Demonstration thereof.

PROP. XXXI.

By knowing the Pole's Altitude, to find when any fixed Star shall be due East or West.

This is the *Analogy* or *Proportion*.
As Radius or S. 90°,

§. 2. *To* T. of the *Stars Declination,*
So is Tc. of the *Pole,*
To Sc. of the *Stars Horary Distance* from the *Meridian.*

PROP. XXXII.

By knowing the Poles Altitude, to find the Elevation of any fixed Star above the Horizon, being due East or West.

This is the *Analogy* or *Proportion.*
As S. of the *Poles Altitude,*
To Radius or S. 90°,
So is S. of the *Stars Declination,*
To S. of the *Stars Elevation,* above the *Horizon,* at due *East* or *West.*

PROP. XXXIII.

To find out the Horizontal Parallax of the Moon.

The *Analogy* or *Proportion.*
As the Moons Distance from the *Center* of the *Earth,*
To the Earth's Semidiameter,
So is Radius or S. 90°,
So S. of the *Moon's Horizontal Parallax* in that Distance.

PROP.

§. 2.

PROP. XXXIV.

The Horizontal Parallax of the Moon being known, to find her Parallax in any apparent Latitude.

This is the *Analogy* or *Proportion.*
As Radius or S. 90°,
To S. of the *Moon's Altitude,*
So is S. of the *Moon's Horizontal Parallax,*
To S. of the *Parallax* in that *Altitude.*

PROP. XXXV.

By knowing the Moon's Place in the Ecliptick, (having little or no Latitude) and her Parallax of Altitude, to find the Parallaxes of her Longitude and Latitude.

Firſt, If the *Moon* be in the 90° of the *Ecliptick,* ſhe hath then no *Parallax* of *Longitude,* and the *Parallax* of the *Latitude,* is the very *Parallax* in that *Altitude.*

Secondly, But if the *Moon* be not in the 90th. Degree of the *Ecliptick,* to find the *Parallaxes* of the *Latitude* and *Longitude,* the *Analogy* or *Proportion* is,

1. *As Radius* or S. 90°,
To T. of the *V.* of the *Ecliptick* and *Horizon,*
So is Sc. of the *Moon's Diſtance* from the *Aſcendent,* or *Deſcendent deg.* of the *Ecliptick,*
To Tc. of the *Ecliptick's V,* with the *Azimuth* of the *Moon.*

§. 2.

AGAIN say,

2. *As the Radius* or S. 90°,
To S. of that *V.* found,
So is the *Parallax* of the *Moon's Altitude*,
To the *Parallax* of her *Latitude* sought.

LASTLY say,

3. *As the Radius* or S. 90°, 00′
To Sc. *of the former V. found*,
So is the Parallax of the Moon's Altitude,
To the Parallax of his Longitude sought, which being added to the true Motion of the *Moon*, if she be on the *East* part of the 90° of the *Ecliptick*. Or from it to be deducted if she be on the *West* part of the 90° of the *Ecliptick*.

PROP. XXXVI.

How by knowing the Refraction of a Star, to find his true Altitude.

For the speedy performance of which I have annexed this Table of *Refractions* of the *Stars* observed by *Tycho Brahe* a Nobleman of *Denmark*, and a most famous *Astronomer*.

A Table

§. 2.

A Table of the Refraction of the Stars observed by *Tycho Brabe*.

Altitude.	*Refraction.*	
0°	30′	00″
1	21	30
2	15	30
3	12	30
4	11	00
5	10	00
6	9	00
7	8	15
8	6	45
9	6	00
10	5	30
11	5	00
12	4	30
13	4	00
14	3	30
15	3	00
16	2	30
17	2	00
18	1	15
19	0	30
20	0	00

The USE of which Table is thus.

EXAMPLE.

Suppose the *Altitude* of a *Star* were found by Observation to be 13°; the correspondent *Refraction* is 4′ 00″, which substracted from 13° leaves 12°, 56′, which is the true Altitude.

CHAP.

CHAP. VII.

Of GEOGRAPHY.

Defin. GEOGRAPHY *is an art Mathematical, which ſheweth how the Situations of Kingdoms, Provinces, Cities, Towns, Villages, Forts, Caſtles, Mountains, Woods, Havens, Rivers, Creeks,* &c. *being on the Surface of the Terreſtrial Globe, may be deſcribed, and deſigned, in commenſuration Analogical to Nature, and Verity: and moſt aptly to our view may be repreſented.*

Ptolomy ſaith of *Geography*, Ἡ Γεωγραφία μίμησίς ὅτι διὰ γραφῆς διαγραφῆς τὰ κατειλημμένα τῆς γῆς μέρη ὅλα, καὶ ἅπερ ὡς ἐπίπαν αὐτῷ συνημμένων. *That it is a deſcription of all the known Earth, imitated by writing and delineation: with all other things belonging thereunto.* Of all which I ſhall ſay ſomewhat, as to its *Situation, Commodity, Cuſtoms,* &c. concerning which *Ovid* ſaith, *Met.* lib. 1.

Terra

Terra, viros, Urbeſque gerit, frugeſque, feraſque,
Fluminaque; hæc ſuper eſt Cæli fulgentis imago.

In Engliſh Thus.

The Earth, Men, Towers, Fruits, Beaſts, and Rivers bears,
And over theſe are place'd the Heavenly Spheres.

SECT. I.

Of GEOGRAPHICAL Definitions.

Defin. 1. THE Globe of the Earth is a Spherical Body compoſed of Earth, and Water, and is divided into *Continents*, *Iſlands* and *Seas*.

2. *A Continent* is a great Quantity of Land, not ſeparated, interlaced or divided by the *Sea*, wherein are *Kingdoms*, *Principalities* and *Nations*, as EUROPE, ASIA and AFRICA, are one *Continent:* and AMERICA is another.

3. *An Iſland* is ſuch a part of the Earth that is environed round with Water on every Side, as the Iſle of *Great Britain*, *Java*, *Wight*, &c.

4. *A Peninſula* is ſuch a Tract of Land which being almoſt cut off from the Main Land, and encompaſſed round with Water, yet nevertheleſs is joyned unto the firm Land, by ſome little *Iſthmus*, as *Peloponeſus*, *Peruviana*, *Taurica*, *Cymtryca* and *Morea* in the *Levant*.

5. *An*

§. 1. 5. An *Isthmus* is a little narrow Neck of Land which joyneth the *Peninsula* unto the *Continent*.

6. A *Promontory* is some high Mountain, which shooteth it self into the Sea, the utmost end of which is called a *Cape*: as *Cape-boon*, *Esperance*, *Cape d' Verde*, and *Cape d' Coquibocao*.

7. The *Ocean* is a general Collection of Waters, which environeth the World on every side, and produceth *Seas*, *Straits*, *Bays*, *Lakes*, and *Rivers*: Of which and other Waters *Ovid* thus speaks in his *Metamorphosis*.

Tum Freta diffudit, rapidisque tumescere ventis
Jussit, & ambitæ circundare littora terræ.
He spread the Seas, which then he did command
To swell with Winds, and compass round the Land.

8. The *Sea* is part of the *Ocean*, to which we cannot come but through some *Strait*, as the *Mediterranean*, or *Baltick Sea*.

9. A *Strait* is a part of the *Ocean* restrained within narrow bounds, yet openeth a way to the *Sea*, as the *Straits* of *Gibralter*, *Helespont*, &c

10. A *Creek* is a crooked Shoar thrusting, as it were, two Armes forth to hold the *Sea*; as the *Adriatick*, *Persian*, and *Corinthian Creeks*: from whence are produced *Rivers*, *Brooks* and *Fountains*: which are engendred of *Congealed Air* in the *Earths Concavity*, and seconded by *Sea-water* creeping through the hidden *Cranies* of the *Earth*.

11. A *Bay* is a great Inlet of Land, as the *Bay* of *Mexico*, and *Biscay*.

12. A *Gulph* is a greater Inlet of Land and deeper

deeper than a *Bay*, as the *Gulph of Venice*, and *Florida*. §. 1.

13. A *Climate* is a certain ſpace of Earth and Sea, included within the ſpace of two *Parallels*; and there have been anciently accounted theſe ſeven: *viz.* 1. *Dia Meros*, 2. *Dia Syenes*, 3. *Dia Alexandria*, 4. *Dia Rhodes*, 5. *Dia Rhomes*, 6. *Dia Boriſthenes*, and 7. *Dia Ripheos*.

14. A *Zone* is a certain ſpace of *Earth* contained betwixt certain *Circles* of the *Sphere*, of which there are five: *viz. The Torrid or Burning Zone, two Temperate, and two Frigid or Frozen Zones.*

The *Torrid Zone* is that which lieth on each ſide the *Equinoctial*, whoſe bounds are the two *Tropicks* of ♋ and ♑.

The two *Temperate Zones* are thoſe which lieth betwixt the two *Tropicks* of ♋ and ♑, and the *Polar Circles*.

The two *Frigid Zones* lieth between the *Artick* and *Antartick Circles*, and their reſpective *Poles*: Of which *Ovid* thus ſpeaks.

Metam. 1.

Utque duæ dextrâ Cœlum, totidemque ſiniſtrâ
Parte ſecant Zonæ, quinta eſt ardentior illis:
Sic onus incluſum numero diſtinxit eodem
Cura Dei, totidemque plaga tellure premuntur:
Quarum quæ media eſt, non eſt habitalis æſtu;
Nix tegit alta duas: totidem inter utramq; locavit
Temperiemque dedit miſtâ cum Frigore Flammâ.

SECT.

§. 2.

SECT. II.

Geographical Descriptions of the Earth.

THE whole Earth is divided into four parts.

VIZ.

EUROPE, *ASIA*, } { *AFRICA* and *AMERICA*.

Europe. EUROPE, the first part of the World, is divided from *ASIA* by the *Mediterranean Sea*; bounded on the West with the *Western Ocean*; East with the River *Tanais*. It is lesser than ASIA, or AFRICA, yet doth excell all the other parts, in *Worthiness*, *Fame*, *Power*, multitudes of well builded *Cities*, strong *Fortifications*, full of a *Wity* and *Learned People*, Courageous *Warriours*, and the knowledge of *God*, better than all the Riches of the World. It once had the dominion of ASIA and AFRICA, and in it were fourteen Mother Tongues, and doth contain these Provinces: *Viz. Italy*, *Spain*, *Alps*, *France*, *Britain*, *Belgia*, *Germany*, *Denmark*, *Sweden*, *Russia*, *Poland*, *Hungary*, *Sclavonia*, *Dacia*, and *Greece*, with its several *Islands*, which shall be mentioned in their due places.

Italy

§. 2. *Europe.*

Italy * the Mother of *Latine* learning, is bounded East with the *Adriatick* and *Tuſcan Seas*, West with *France*, North with *Germany*, and South with the River *Varus*, and the *Alps*. It hath had ſeven kinds of Governments: Firſt *Kings*, *Dictators*, *Conſuls*, *Decimivires*, *Tribunes*, *Emperours*, and laſtly *Popes*. It far excelleth all the other Lands in *EUROPE* in fruitfulneſs and pleaſantneſs. The Inhabitants are witty and frugal, yet hot and laſcivious, and very jealous of their Wives; they are of the *Popiſh* Religion, and its chief Commodities are *Rice*, *Silk*, *Velvets*, *Sattins*, *Taffeties*, *Grogerams*, *Arras*, *Gold* and *Silver*, *Threed*, *Venetian Glaſſes*, &c.

* *Which* Pliny *hath adorned in theſe words (ſaith he) Italia terrarum omnium alumna, eadem & parens, numine Deûm electa, qua Cœlum ipſum clariùs faceret, ſparſa congregaret imperia, ritus molliret, tot populorum diſcordes linguas ſermonis commercio ad Colloquia diſtraheret, & humanitati hominem daret*, i. e. Italy *(ſaith* Pliny*) is the Nurſe and the Parent of all Religion, was elected by the Providence of the* Gods, *to make (if poſſible) the* Heavens *more famous; to gather the ſcattered* Empires *of the World into one Body, to temper the* Barbarous *rites of the Nations, to unite ſo many diſagreeing* Languages *of Men by the benefit of one common Tongue: and in a word to reſtore Man to his Humanity.*

Italy at this day contains the Kingdom of *Naples*, *Sicily*, *Sardina*, the Lands of the *Pope*, now *Innocent the XI.* the Dukedom of *Tuſcany*, *Urbin*, *the Republick of Venice*, *Genoa*, *and Luca*. The Eſtates of *Lumbardy*, being the Dukedom of *Millain*, *Mantua*, *Modena*, *Parma*, *Mountferrat*, and the *Principality of Piemont*, of all which we ſhall treat in their order.

The

Europe. §. 2. The Kingdom of *Naples* is environed with the *Adriatick*, *Ionian*, and *Tuscan Seas*; except where it is joyned to the Lands of the *Church*, from which 'tis separated by a line drawn from the mouth of the River *Tronto*, falling into the *Adriatick*, and to the spring-head of *Axofenus*, taking in all the East of *Italy*, 1468 miles. It is very fertile, abounding with all things necessary for the life of Man, delight, and *Physick*: from hence come the *Neopolitan* Horses. It hath had 13 *Princes*, 24 *Dukes*, 25 *Marquesses*, 19 *Earls*, and 900 *Baronets*, and 26 *Kings* of several Countries of the *Norman* and *Spanish* race, whom 'tis now under: here the Disease called the *French-Pox* derived its *Original*: the Arms are *Azure Seme* of *Flower-de-lices*, or a File of three *Lables Gules*; its revenues are 2500000 *Crowns*, 20000 of which belongs to the *Pope*, and the rest are imployed to maintain the *Garisons* against the *Turks*; so that scarcely 60000 *Crowns* falls to the King of *Spain*'s share; it hath 20 *Archbishops*, and 124 *Bishops* Sees.

Sicily is situated under the fourth *Climate*, it shoots forth into the Seas with three *Promontories*; the Inhabitants are Eloquent, Ingenious, and Pleasant, but very unconstant, and Talkative; the first Inventors of *Oratory*. It's a fruitfull Soil, it yields *Wine*, *Grain*, *Oyl*, *Hony*, *Gold*, *and Silver*, *Agats*, *Emeralds*, *Allom*, *Salt*, *Sugar*, *and Silks*. Here is the Hill *Ætna*, supposed to be Hell, and by the *Papist Purgatory*, because of its vomiting Smoak and Fire: it hath many *Cities*, *Rivers*, *Lakes*, whose descriptions must here be omitted; it hath had eight Kings; the first were of the *Arragon* Family, and began

to

Rule *Anno* 1281. But it's now united to the Crown of *Spain*; its Revenues are 800000, or a 1000000 of *Ducats*, which is disburſt on the Account of the *Vice-Roy*, and Defence of the Countrey; the Arms are four *Pallets Gules*, Sable for *Aragon*, between two *Flanches Argent*, charged with as many Eagles *Sable beaked Gules*. It hath had ſeven *Princes*, four *Dukes*, thirteen *Marqueſſes*, fourteen *Earls*, one *Viſcount* and forty-eight *Barons*, they are of the *Romiſh* Religion, and have three *Archbiſhops*, and nine *Biſhops*. §. 2. *Europe.*

The Kingdom and Iſle of *Sardina*, lieth Weſt from *Sicily* and *Cap Bara*, whoſe length is 180, and breadth 90 Miles; the People are low of Stature, and of a ſwarthy Complection, rude, ſlothfull, and rebellious, their diet mean, yet rich in their Apparel, they are of the *Romiſh* Religion; but have an ignorant and illiterate *Clergy*. It belongs to the King of *Spain*, and governed by a *Vice-Roy*, under whom are two *Deputy Spaniards:* but other inferiour Officers may be Natives. It hath neither *Wolf*, nor *Serpent*, nor venemous Beaſt, but the *Fox* only, and a little *Spider*, which cannot endure the light of the *Sun*; they are deſtitute of Water, and are therefore forced to keep the Rain that falls in *Summer* for their Uſe in *Winter*, the Air is unhealthfull and *Peſtilential*; the Soyl Fertile, but ill manured; it hath plenty of *Cattel*, their *Horſes* will laſt very long, the Natives ride on their *Bullocks* as we on our Horſes, here is alſo a Beaſt called *Mufrones*, reſembling a Stagg, whoſe Hide is uſed as Armour, and an Herb which eaten produces Death with exceſſive laughter, it yields to the King of *Spain* but a

§. 2. ſmall Revenue. The Arms are *Or*, a Croſs *Gules* betwixt four *Sarazens Heads*, Sabled Curled *Argent*, it hath ſeveral *Iſles* belonging thereunto, it hath three *Archbiſhops*, and fifteen *Biſhops*.

Europe.

The Lands of the *Church* or the *Pope's Dominion* in *Italy*, lieth Weſt of *Naples*, extended North and South from the *Adriatick to the Tuſcan Seas*, bounded on the North with the River *Trontus*; on the South-eaſt with *Axofenes*: hy the Rivers *Poe* and *Frore*, ſeparated from the *Republique* of *Venice*, on the South-weſt by the River *Piſcio*; by which 'tis divided by the Modern *Tuſcany*, it is in the middle of *Italy*, its breadth is 115, and length 300 Miles, it's moſt exceeding fruitfull, very Populous, there have been 15 *Exarches* of *Ravena* in *Romandiola*, 17 *Dukes* and *Marqueſſes* of *Ferata*; the Revenue thereof to the Pope is 250000 Crowns, there hath alſo been 6 *Dukes* of *Urbin*, its Revenue are 100000 Crowns, but the moſt ſplendid Glory of *Italy* is the City of *Rome*, ſometimes the Empreſs of the World, and was the Seat of the paſt Popes, and the now preſent *Pope Innocent the XI.* the inferior ſpiritual Governours, are theſe, *Viz. Cardinals*, *Friers* of the Order of St. *Baſil*, *Auſtin*, *Jerome*, *Carmelites*, *Crouchedfriers*, *Dominicans*, *Benedictines*, *Franciſcans*, *Jeſuits and Oratorians*; and of *Nuns*, the Order of St. *Clear* and *Bridget*, which to name wholly doth deſerve a particular Treatiſe, here are 44 *Archbiſhops*, and 57 *Biſhops*.

The Republique of Venice, lieth Northward of the *Popes Dominions*, from *Romandiola* to the *Alps*, limited on the South with the Territories of

of *Ferrara*, and *Romandiola*; on the West with the *Dukedom of Millain*; on the North with the *Alps*; and on the East with the *Adriatick Sea*, and the River *Arsia*. It is a very fruitfull Countrey, well peopled, their Government *Aristocratical*, and popular, their Religion *Popish*, they baptize the Sea yearly; they have had a hundred *Dukes*, they have two Principal Orders of Knighthood of St. *Mark* the Patron of the famous City of which the Poet speaks. §. 2. *Europe.*

Viderat Adriacis venetiam Neptunus inundis
Stare Urbem, & toto ponere jure mari:
Nunc mihi Tarpeias, quantumvis Jupiter, arces
Objice, & illa tui mœnia martis ait.
Sic Pelago Tibrim præfers, urbem aspice utramq;
Illam homines dices, hanc posuisse Deos.

Instituted 1330, and renewed 1562, they are to be all of Noble Blood: their Motto is *Pax tibi Marce*. The other is of the Glorious *Virgin*, instituted 1222, their Duty is to be a refuge to *Widows* and *Orphans*, and to procure the peace of *Italy*; their Habit a *White Surcoat* over a *Russet Cloak*, representing *Religion*, as well as *Belliarcity*, there are two *Patriarchs*, and sixteen *Bishops*.

The Dukedom of *Florence*, being the Seat of the Great Duke of *Tuscany*, is bounded on the East by the River *Pisca*; on the West by the River *Macra*, and the Fort *Sarzana*; on the North by the *Appenuine* Hills; and on the South with the *Tuscan Seas*. Its length is 261 Miles; and breadth not known; the Order of Knighthood is that of St. *Stephen*, instituted 1567, they

§. 2. Europe.

are to be Nobly born, and in lawfull Wedlock, without Infamy: their Robe is of White *Chamblet*, with a *Red-Cross* on the left Side of their Midway Garment, their Number I cannot certainly know, the *Grand Duke* is their *Sovereign*; the Revenue of this Countrey is great, their *Duke* is also a Merchant, and receiveth *Excise* of all *Commodities*, the Arms is *Or*, five *Torteaux Gules*, two, two, and one, one, on chief *Azure* charged with three *Flower-de-Luces*, of the first. They are of the *Popish* Religion, and they have three *Archbishops*, and twenty six *Bishops*.

The Estate of *Luca*, lieth betwixt the Estate of the *Grand Duke, and the Republique of Genoa*: The Government is *Aristocratical, and Democracy*, their Principal Magistrate is called, *Gon Fatinere*, and is changed every second Month: being assisted by a certain Number of Citizens, which are changed every six Months, during which time they lie together in the *Common Hall*; their *Protector* is Elective from some Neighbouring Prince: they are a very generous People, good Merchants, they sell rich Cloths of *Gold* and *Silver*; the Revenues yearly are 80000 *Crowns*, it can raise for War 15000 *Foot*, and 3000 *Horse*, they are of the *Popish* Religion, and have two *Bishops*, and acknowledge the *Bishop* of *Florence* for their *Metropolitan*.

The Republique of *Genoa*, lieth West of *Tuscany*, from whence 'tis divided by the River *Macra*, it was formerly a large State but have now only *Liguria*, and the Isle of *Corsica*; the Inhabitants are good Warriours, Merchants, and subtle *Userers*; here the Women have the most liberty

§. 2. Europe.

liberty of any in all *Italy*, ſo that they may converſe with whom they will, either publiquely, or privately; from hence ariſeth a Proverb, *That Genoa is a Country of Mountains without Woods; Seas without Fiſh; Men without Faith; and Women without ſhame.* They have a *Duke*, with Eight *Aſſiſtants*, all ſubject to the General Council of 400 Men; which hold but two years, they are of the *Popiſh* Religion, and have one *Archbiſhop*, and fourteen *Biſhops*.

The Eſtates of *Lumbardy* is bounded on the Eaſt with *Romandiola*, and *Ferrata*; on the Weſt and North with the *Alps*; and on the South with the *Apenuine* hills: Now as *Italy* is the Garden of EUROPE, ſo is *Lumbardy* of *Italy*, for its exceeding Fruitfulneſs.

The Dukedom of *Millain* hath on the Eaſt the State of *Mantua*, and *Parma*; on the Weſt *Piemont*, and part of *Switzerland*; on the North *Marca Trevigana*; and on the South the *Apenuine*, parting it from *Liguria*: it was once the chief Dukedom in Chriſtendom, and is now in the *Spaniſh Territories*; its Revenues are 8000 *Ducats*, their Arms are *Argent*, a *Serpent Azure* Crown'd, *Or*, in his *George* an *Infant Gules*, their Religion is *Popiſh*, they have one *Archbiſhop*, and ſix *Biſhops*.

The Dukedom of *Mantua*, is bounded Weſt with *Millain*; Eaſt with *Romandiola*; North with *Marca Triugiana*; and South with the Dukedom of *Parma*. The Countrey yields good ſtore of *Corn*, *Fruit* and *Wine*, the Inhabitants are ruſtick, fooliſh in their Apparel, it is a free ſtate and hath had many Dukes, the Order of Knighthood is that of the *Blood* of *Chriſt*: in-

§. 2. *Europe.*

stituted 1608, it consisteth of twenty Knights, the *Mantuan Duke* is their *Sovereign*; the Collar hath threads of Gold, layed on with Fire, with this Motto *Domine probasti*, to the Collar are pendent two *Angels*, supporting three drops of *Blood*, and circumscribed with this Motto, *Nihil ista triste receptô*. Its Revenue is 500000 Ducats; Its Arms are *Argent*, a Cross *Patere Gules*, between four Eagles, *Sable* membred of the second, under an *Escbucheon* in *Fife*, charged quarterly with *Gules*, *a Lion Or*, and *Or*, three barrs Sable: Their Religion is *Popish*, here is one *Archbishop*, with four *Bishops*.

I shall pass by the Dukedoms of *Modena*, *Parma* and *Mountferrat*, they being but small Estates of *Italy*, having but four *Bishops*: they are of the *Popish Religion*, the Arms of *Modena* and *Parma* are as *Ferrata*; and the Arms of *Mountferrat*, a chief *Argent*.

And here we should describe *Piemont* the last part of *Italy*, but being but part in *Italy*, and the *Alps* belonging to the Duke of *Savoy*, I shall defer it to the *Alpian* Descriptions.

Now *Italy* hath these most famous Cities, *viz. Genoa*, *Milain*, *Venice*, *Florence*, *Rome*, *Bologne* and *Naples*, the Rivers most famous are *Arnus*, *Po* and *Tiber*, and so much for *Italy*.

The *Alps* begin about the *Ligustick Seas*, and crosseth all along the Borders of *France* and *Germany*, and extend as far as the *Gulph* of *Cornero*; It hath these Provinces, *viz.* the Dukedom of *Savoy* (to which *Piemont* belongs) *Geneva*, *Wallisland*, *Switzerland*, and the Countrey of the *Grizons*, of all which I shall give a short and plain Description.

Piemont

§. 2.

Europe.

Piemont is part of the *Alps*, ſituated at the Foot of the Mountains, bounded North with the *Switzes*; Eaſt with *Millain and Mountferrat*; Weſt with *Savoy*; and on the South it runneth into a Narrow Vally to the *Mediterranean*, having *Mountferrat* on one ſide, and *Province* and part of the *Alps* on the other: it's very fruitfull compar'd with *Savoy*, but yet inferiour to any part of *Italy*: The Arms are *Gules*, a Croſs *Argent*, charged with a *Lebel* of three points *Azure*.

Savoy is bounded Eaſt with *Walliſland* and *Piemont*; Weſt and South with *Daulphin*, and *La-Breſs*; and North with *Switzerland*, and the Lake of *Geneva*: this is a Mountainous Countrey, very healthfull, but not very fruitfull. The Inhabitants are dull and ſlothfull, it hath had thirty *Dukes* and *Earls*, it is a place of Natural ſtrength; its Revenues is yearly 1000000 of *Crowns*. The order of Knighthood is that of *Anunciado*, inſtituted 1480, their Coller hath 50 links, (to ſhew the Myſtery of the Virgin) appendent to it is her Effigies, and inſtead of a Motto theſe Letters F. E. R. T. i. e. *Fortitudo ejus Rhodum tenuit*, which is engraven on each link of the Chain, interwoven like a True-lovers-knot, The Number fourteen, beſides the *Duke Soveraign* of the Order, their Arms are *G.* a Croſs *A.*

Geneva was a City of the Dukedom of *Savoy*, but now a free State: having both caſt off the Duke and his Holineſs the *Pope*, with all the *Clergy*. They are now *Calvaniſt Proteſtants*: their Government *Presbyterial*; their Language the worſt of *French*, they are an induſtrious People, and good Merchants.

§. 2. *Europe.*

Walliſland reacheth from the Mount *De Burken*, to the Town of St. *Maurice*, where the Hills do ſhut up the Valleys, ſo that a Bridge is lain from one Hill to 'tother, under which paſſeth the River *Roſue*, which Bridge is defended by a Caſtle and two ſtrong Gates; on the other ſide 'tis ſurrounded with ſteep and horrid Mountains; covered with a Cruſt of *Ice* not paſſable by Armies; the Inhabitants are courteous to Strangers, but unnatural to each other: they are of the *Romiſh* Religion, and ſubject to the Biſhop of *Sion*; the Deputies of the ſeven *Reſorts*, have voices in his Election, and joyn with him in *Diets*, for chuſing Magiſtrates; deſiding Grievancies, and determining matters of State. The Valleys of this Countrey is very fruitfull in *Saffron*, *Corn*, *Wine* and *Delicate Fruits*, they have a Fountain of *Salt*, many hot *Baths*, and *Spaw-Waters*, they have plenty of *Cattle*, with a wild *Stag* footed as a *Goat*, and horned as a fallow *Deer*: who in Summer is blind with heat.

Switzerland is bounded Eaſt with the *Griſons*; Weſt with *Mount-Jove* and the Lake of *Geneva*; North with *Suevia*; and South with *Walliſland*, and part of the *Alps*; this Land is a very Mountainous Countrey, but yet hath ſome rich Meddows. It is 240 in length and 180 Miles in breadth, the Inhabitants are rich, but rugged like their Soyl: good Souldiers: they are ſome *Papiſts* and ſome *Proteſtants*, others *Zwinglians*, yet have they toleration under a *Popular* Government.

The Countrey of the *Griſons* is bounded Eaſt with *Tyrol*, North with *Switzerland*, South with

with *Suevia*, *Switzerland*, and *Lumbardy*; it is a very Mountainous and Barren Land, their Religion *Proteſtant*, their Government *Popular*; there are in this *Alpin* Provinces two *Archbiſhops*, and thirteen *Biſhops*. Its chief Cities are *Turin*, *Geneva*, *Baſil* and *Zurich*, in all of which are Univerſities. §. 2. *Europe.*

France is bounded Eaſt with *Germany*; and South and Eaſt with the *Mediterranean Seas* and *Alps*; North with the *Britiſh Seas*; It hath been eſteemed the worthieſt Kingdom in Chriſtendom, it yields plenty of *Grains* and *Wines*, wherewith it ſupporteth other Lands, it conſiſteth of many great *Dukedoms* and *Provinces*. It hath great and mighty Cities, the People are Ingenious and good Warriers, the Government is *Monarchial*, their Religion *Popiſh*, but intermixt with *Proteſtants*, which of late hath endured grievous Perſecutions. Their Orders of Knighthood are that of St. *Michael* inſtituted 1409, conſiſting of 300 Perſons, their Habit is a long Cloak of *White Damask* down to the Ground, with a Border interwoven with *Cockleſhels* of Gold, interlaced and furred with *Ermins*, with a Hood of *Crimſon-velvet*, and a long *Tippit* about their Necks, and a Coller woven with *Cockleſhells*, with this Motto, *Immenſi tremor Oceani*, to it hangs appendent the Effigies of St. *Michael* conquering the *Dragon*. Their Seat is St. *Michael's Mount* in *Normandy*. 2dly the Order of the Holy Ghoſt inſtituted 1579, ſo that whoſoever was admitted to the Order of St. *Michael*, muſt and was firſt dignified with this; proving their Nobility by three Deſcents; and be bound by Oath to maintain

the

§. 2. the *Romiſh* Religion; and perſecute all Diſſenters thereunto. Their Robe is a *Black Velvet Mantle*,

Europe. portrayed with *Lillies* and *Flames* of *Gold*: the *Coller* of *Flower-de-Luces*, and Flowers of *Gold*, with a *Dove* and *Croſs appendent* to it. The Arms of *France*, are *Azure* three *Flower-de-Luces*, *Or*; It hath ſeventeen *Archbiſhops*, 107 *Biſhops*, 132000 *Pariſhes*, and hath theſe Magnificent Cities, *viz. Amiens*, *Rouen*, *Paris*, *Troys*, *Nants*, *Orleans*, *Dijon*, *Lyons*, *Burdeaux*, *Touloſe*, *Marſailles*, *Grenoble* and *Anverſe*; the Rivers of moſt Note are the *Loyre*, *Garone*, *Rhone* and the *Seyne*.

The *Pirenean-hills* lyeth betwixt *France* and *Spain*, and are two Potent Kingdoms, eſteemed 240 Miles long, the People are barbarous and ſcarce of no Religion at all.

Spain is ſeparated from *France* by the *Pirenean-hills*; on all other ſides environed with the *Sea*; this Land yieldeth all ſorts of *Wine*, *Oyl*, *Sugars*, *Grains*, *Metals*, as *Gold* and *Silver*, and it is Fertile; the Inhabitants are *Ambitious*, *Proud*, *Superſtitious*, *Hypocrites* and *Laſcivious*, yet good Souldiers; by enduring *Hunger*, *Thirſt*, *Labour*, &c. It containeth divers Kingdoms. 1. *Goths*. 2. *Navars*, it hath had 41 *Kings*. Their Arms are *Gules*, a Carbuncle *Nowed Or*, their Order of Knighthood was of the *Lilly*, their Blazon a Pot of *Lillys*, with the *Effigies* of the *Virgin* on it, their Duty is to defend the Faith, and daily to repeat a certain Number of *Ave-Maries*. 3dly *Biſcay* and *Empaſcon*, hath had nineteen *Lords*, their Arms *Argent*, two *Wolves Sable*, each in his Mouth a *Lamb* of the ſecond. 4ly *Leon* and *Oviedo* hath had thirty

Kings

Kings, the Arms *Argent*, a *Lion Paſſant* crowned *Or*. 5ly. *Galicia* hath had ten *Kings*, the Arms *Azure Sema* of Creſſels ſiched a *Chalice* crowned *Or*. 6ly. *Corduva* hath had twenty *Kings*, the Arms *Or*, a *Lion Gules* armed and crowned of the firſt, a Border *Azure* charged with eight *Towers Argent*. 7ly. *Granado* hath had twenty *Kings*, the Arms *Or*, a *Pomgranet* ſlipped *Vert*. 8ly. *Marcia*. 9ly. *Tolledo* hath had eleven Moriſh *Kings*. 10ly. *Caſtile* hath had twenty *Kings*, the Order of *Mercia* is his chief Order, here the Armes is a Croſs *Argent*, and four *Beads*, *Gules* in a Field *Or*, their Habit white, the Rule of their Order that of St. *Auguſtine*, they are to redeem Captives from *Turky*. 11ly. *Portugal* (the Native ſoyl of the moſt ſerene *Catharine Queen Dowager*) hath had 21 *Kings*, the Orders of Knight here is firſt *Avis*, wearing a Green Croſs, 2dly of *Chriſt* inſtituted 1321, their Robe is a black Caſſock under a white *Surcoat* with a Red Croſs hanging in the midſt a white Line, and their Duty is to expell Mores out of *Boetica*, the Arms are *Argent*, on five *Eſcucheons Azure*, as many *Befants* in ſaltire of the firſt pointed, Sable within a powder *Gules*, charged with ſeven *Towers Or*. 12ly. *Majorica* hath had four *Kings*. 13ly. *Arragon* hath had twenty *Kings*, their Order of Knighthood is of *Minteſa*, their Robe a red Croſs on their Breaſt, the Arms *Or*, four *Pallets Gules*, all which Kingdoms are now united into one *Monarchy*, under the *King* of *Spain*, their Religion *Popiſh*: the King is not rich by reaſon of his great Expences to keep his Dominions, in which are eleven *Archbiſhops*, and

§. 2. *Europe.*

§. 2. and 52 *Bishops*, and hath these most notable Cities, *viz. Toledo, Madrid, Leon, Fax, Sivil-*
Europe. *le, Grenado, Mursy, Saragosa, Bracelon, Pamphelune, Bilbo, Priede*, St. *James* of *Compostella*, and *Lesbone*, and Rivers famous are the *Dower*, *Tagus*, *Gadian* and *Guadalguinr*.

Great Britain consisteth of *England* and *Scotland*, and is the Biggest Isle in *EUROPE*, and the *Glory* thereof; it is a temperate Soyl, a sound Air, and yieldeth all manner of good things, 'tis environed all round with the Seas; I shall begin first with *England*.

England hath many pleasant Rivers well stored with *Fish*, excellent *Havens*, commodious *Mines* of *Silver*, *Lead*, *Iron* and *Tinn*, abundance of *Woods*, good *Timber*, plentifull in *Cattle*, good *Wool* of which is made fine Cloath, which serves not only themselves but vended into other Countreys, the chief City is *London*, in which are two of the Wonders of the World, *viz.* the *Monument* and *Bridge* over the *Thames*, the People are brave Warriers, both by Sea and Land, as *Europe* has felt and can testifie to their Grief, they are learned in all manner of noble Sciences; the Order of Knigthood is that of St. *George*, or the *Garter*, there are 26 Knights of it, whereof the *King* is the *Soveraign*, their Ensign is a blue Garter buckled on the left Leg, with this Motto—*Hony Soit Qui Mall Y Pense*, and about their Necks they do wear a blue Ribbon, at the End of which hangs the Image of St. *George*, upon which day this Order is Celebrated: secondly of the *Bath*, instituted 1009, they use to be Created at the *Coronation* of *Kings* and *Queens*, and at the *Enstalling*

of

of the *Prince* of *Wales*. The Knights thereof distinguished by a red Ribbon, which they wear about their Necks, their Duty is to defend *Religion*, *Widows*, *Maids* and *Orphans*, with the *Kings right*. Thirdly of *Barronets* and *Hereditary Honour*, the Arms are *Mars*, three *Lions Passant*, *Gardant Sol*, their Religion is the *Protestant*; they have two *Archbishops* and twenty *Bishops*. The length of *England* is 320, and breadth 250 Miles, it hath 857 famous *Bridges*, 325 Rivers, it's defended and invironed with Turbulent *Seas*; guarded by unaccessible *Cleves* and *Rocks*; and defended by a strong and Puissant *Navy*; so that of it may well be said, §. 2. *Europe.*

Insula prædives, que toto vix eget Orbe;
Et cujus totus indiget Orbis ope.
Insula prædives, cujus miretur & optet
Delicias Solomon *octavianus opes.*

Its chief Cities are *London*, *York*, *Bristol*, and Rivers are the *Thames*, *Severn*, *Humber*, and the *Ouze*.

Wales is bounded on all sides with the Sea, except towards *England* on the East; it is a barren and mountainous Countrey: Its chief Commodities are their *Freeze*, and *Cottons*. The Inhabitants are faithfull in their promises to all men, but yet much enclined to Choler, and subject to Passion, which *Aristotle* calleth ἀκεφαλία. It contains 14 *Shires*, 13 *Forests*, 36 *Parks*, 230 *Rivers*, and 1016 *Parishes*. They are so resolute and valiant (saith *Henry* III. writing to *Emanuel* then *Emperour* of *Constantinople*) "*That they dare encounter Naked with*

"*armed*

§. 2. " *armed Men, being ready to ſpend their Blood for* " *their Country, and pawn their Life for Praiſe.*

Europe. They are *Proteſtants*, and have four *Biſhops*, but no Towns of Note.

Scotland is the Northern part of *Britain*, environed all round with the *Sea*, unleſs where it is joyned to *England*. *Polydore* ſaith it is 480 in length, and 60 miles in breadth, divided into *Highlands* and *Lowlands*: the *Highlands* are *Iriſh-Scots*, and the *Lowlands Engliſh-Scots*. It is not ſo fruitfull as *England*; the chief City is *Edenbrough*. Its Commodities is courſe *Wool*, and *Cloth*, *Malt*, *Hides*, and *Fiſh*. The Order of Knighthood is that of St. *Andrew*, the Knights did wear about their Necks a Coller interlaced with *Thiſtles*, with the Picture of St. *Andrew* appendant thereunto, having this Motto—— *Nemo me impune laceſſit*. 2. Of *Nova Scotia* inſtituted by King *James*, *Anno* 1622, hereditary the Knight hereof diſtinguiſhed by a Ribbond of *Orange-tawny*. The Arms of *Scotland* is *Sol*, a *Lion Rampant*, *Mars* within a double *Treſſure* counterflowered; they are *Proteſtants*, and have 2 *Archbiſhops* and 12 *Biſhops*. The Cities moſt Famous are *Edenbrough*, *Sterlin*, *Aberdeen* and St. *Andrews*: and they have the Famous Rivers *Tay* and *Tweed*.

Ireland is on all ſides environed round with the *Iriſh Seas*, and St. *Georges Channel*. Its length is 300 and breadth 120 miles. The Natives are *ſtrong* and *nimble*, *haughty*, *careleſs*, *hardy*, *bearing cold and hunger with patience*; and in a word, if they are bad you ſhall never find worſe; but if good ſcarcely find better. The *Wild Iriſh* have a cuſtom to kneel down to

§. 2. *Europe.*

the *New Moon*, praying it to leave them in as good health as it found them. They received the Chriſtian Faith 435. The Soil is fruitfull and it hath good *Paſture*, yet full of *Boggs* and *Woods*, and multitude of *Fowls*, and in it will dwell no venomous Creature. The Revenues yearly have been 40000 *li.* The Air is Temperate, cooler in *Summer*, and hotter in the *Winter* than in *England.* Their Arms are *Azure* an *Harp* or *ſtringed Argent*, they are ſome *Proteſtants* and *Papiſts* mixt: they have 4 *Archbiſhops*, and 19 *Biſhops*; the chief City is *Dublin.*

The *Iſlands* belonging to *Great Britain*, are 1. *Wight* (the place where I firſt drew my Breath, and the Land of my Nativity) 2. *Surlings*, 3. *Garnſey*, 4. *Jerſey*, 5. *Angleſey*, 6. *Man*, 7. *Hebrides*, 8. *Orcades*, 9. *Portland*, 10. *Sunderland*, 11. *Holy Iſland.* And thus I have done with the *Britiſh Empire*; all theſe Parts deſcribed belong to it, and are under the Royal Sceptre of his Sacred Majeſty *JAMES* the Second (whom God long preſerve.) Thus I have finiſhed the deſcription of *Great Britain* having this only to ſay—— *Quæ Deus conjunxit nemo ſeparet.*

Belgia, or the *Low Countreys*, conſiſteth of ſeveral wealthy Provinces: *viz.* The Dukedom of *Brabant*, *Guelderland*, *Lymburge*, *Flanders*, *Artois*, *Henault*, *Holland*, *Zeland*, *Mamen*, *Zukfen*, the *Marquiſate* of the *Holy Empire*, *Freezeland*, *Michlen*, *Ouſeriſen*, and *Graving.* All which Lands are very fertile and populous, having 208 *Cities*, and 6300 *Villages*, with *Pariſh-Churches*, *Caſtles*, and *Forts*; and is watered with

§. 2. with the *Rhine* and the *Moſe*, the *Mara* and the *Sheld*. It hath commodious *Havens*, the
Europe. Inhabitants are brave *Warriours*, good *Mechanicks*, their chief Commodity is *Rheniſh Wine*, *Linnen* and *Woollen Cloth*, *Camericks*, *Lace* of *Gold* and *Silver*, *Silk*, *Taffatys*, *Velvet*, *Grogerams* and *Sayes*, all manner of *Twined threds*, *refined Sugars*, *Buff*, *Ox-hides*, *Spaniſh-leather*, *Pictures*, *Books*, *Cables*, *Ropes* and *Herrings*. Now *Belgia* is bounded Eaſt with *Weſtphalen*, *Gulick*, *Cleve*, and the Iſle of *Triers*; Weſt with the Main *Ocean*; North with the River *Ems*; and South with *Picardy* and *Champagne*. The People are of the reformed Religion all except *Flaunders* and *Artoiſe*, and they have the *Popiſh Tenents*, here are three *Archbiſhops*, and fifteen *Biſhops*. The Order of Knighthood is that of the *Golden Fleece*, inſtituted 1439. their Habit is a Coller of Gold, interlaced with *Iron*, Or. *Ex ferre Flammam*, at the end thereof hangs a *Golden Fleece*. Their chief Cities are *Mentz*, *Antwerp*, *Amſterdam*, *Roterdam*, and Rivers are the *Sheild* and *Moſa*.

Germany is the greateſt Province in all *EUROPE*, and is bounded Eaſt with *Ruſſia*, *Poland* and *Hungary*; Weſt with *France*, *Switzerland* and *Belgia*; North with the *Baltick Seas*, and part of *Denmark*; and South with the *Alps* and parted from *Italy*: it contains *Bohemia* and *Pragu*, it is adorned with Magnificent *Towers*, ſtrong *Fortifications*, *Caſtles* and *Villages*, very Popular; the Soyl is Fertile; many Navigable Rivers do to it belong, Good *Spaws*, *Hot Baths*, Mines of *Gold* and *Silver*, *Tinn*, *Copper*, *Lead* and *Iron*; they are ſome *Papiſts*,

piſts, others *Proteſtants*, *Zwinglians*, *Calviniſts*, and *Lutherans*. The Arms is *Sol*, an Eagle diſplayed with *two Heads*, *Saturn* armed, and Crowned *Mars*. There are ſix *Archbiſhops*, and 34 *Biſhops*. They are a People much given to drinking; which made the Poët ſay—— §. 2. *Europe.*

Germani poſſunt cunctos tolerare labores,
O utinam poſſent tam bene ferre ſitim.

The chief Cities of *Germany* are theſe, *viz. Strasborough*, *Cologn*, *Munſter*, *Norimbergh*, *Ausburg*, *Numick*, *Vienna*, *Prague*, *Dreſda*, *Berlin*, *Stetin*, *Lubeck*; Its chief Rivers the *Rhine*, *Weſer*, *Elbe*, *Oder*, and the *Danow*, and Cities of *Bohemia*, are *Cutenberg*, and *Budrozu*.

Denmark and *Norway*, are two great Regions and bounded South with *Germany*; they have North Latitude 71° 30′, toward the Eaſt they border on *Sweden*; and elſewhere environed with the *Sea*. Their Commodities are *Oxen*, *Grain*, *Fiſh*, *Tallow*, *Sand*, *Nuts*, *Oyl*, *Hides*, *Goat-skins*, *Fir-trees* for *Maſts*, *Boards*, &c. *Pitch*, *Tarr* and *Brimſtone*: they are *Lutherans*. The Order of Knighthood is that of the *Elephant*, their Badge a Coller powdered with *Elephants* Towred, ſupporting the Kings Arms; having appendent the Effigies of the *Virgin Mary*; the Arms of the Land are Quarterly. 1. *Or*, three *Lions* paſſant *Vert*, Crowned of the firſt, for the Kingdom of *Denmark*. 2dly, *Gules* a Lion Rampant, *Or*, Crowned and Armed of the firſt, in his Paws a *Dansk* hatchet; *Argent*, for the Kingdom of *Norway*. There are two *Archbiſhops*, and 13 *Biſhops*; its chief City is *Coppenhagne*.

§. 2. *Europe.*

Sweden is a mighty Kingdom, is bounded Eaſt with *Muſcovia*, Weſt with the *Dorſirin hills*, North with the *Frozen Ocean*, and South with *Denmark*, *Lieſland* and *Mare Balticum*; the Commodities are *Copper*, *Iron*, *Lead*, *Furr*, *Buff*, &c. They are brave Warriers, their Religion is *Lutherans*. The Arms *Azure* three Crowns *Or*, it hath two *Archbiſhops*, and eight *Biſhops*.

Ruſſia is bounded Eaſt with *Tartaria*, Weſt with *Livonia* and *Finland*, North with the *Frozen Ocean*, and South with *Lituania*, and *Mare Caſpium*. This Countrey is extreme cold: but yet Nature hath counterpoized it by ſupplying the Land plentifully with the beſt of *Furrs*, viz. *Sable*, *White-fox*, *Martin*, &c. It's ſubject to the Emperour of *Ruſſia*; a vaſt Tract, and as wild a Government. The Inhabitants are *Baſe* and *Ignorant*, *Contentious* and *Fooliſh*, they deny the proceeding of the *Holy-Ghoſt*, they bury their Dead upright, with many other fooliſh Ceremonies; *Muſcovia* is the Seat of the *Empire*. Its Commodities are *Furrs*, *Flax*, *Ropes*, *Hides*, *Fiſh*, and *Whales-greaſe*. The Arms are *Sable*, a *Portal* open of two Leaves, and as many degrees *Or*, they are of a mixt *Romiſh* Religion, not obſerving Learning as any thing: They have one *Patriarch*, two *Archbiſhops*, and eighteen *Biſhops*. Its chief Cities are *Mucon*, *Wolodimax*, St. *Michael*, *Cazan*, and *Aſtracan*, it's chief Rivers are the *Dwine*, *Volaga*, and the *Tana*.

Poland is bounded South of *Moldavia* and *Hungary*; Eaſt with *Moſcovia*, and *Tartaria*; Weſt with *Germany*; and North with the *Baltick* Seas. The Commodities are *Spruce-Beer*, *Amber*, *Wheat*,

Wheat, *Rye*, *Hony*, *Wax*, *Hemp*, *Flax*, *Pitch*, *Tarr*; it hath Mines of *Tinn* and *Copper*; their Religion is partly *Romiſh*, and partly of the *Greek-Church*, and ſo there are of the *Greek* Church, two *Archbiſhops*, and ſix *Biſhops*, and of the *Romiſh Church* three *Archbiſhops*, and nineteen *Biſhops*: The Arms are Quarterly. 1. *Gules* an Eagle *Argent* Crowned and Armed *Or*, for *Poland*, and two *Gules* a *Chevalier* armed *Cap-a-peid*, advancing his Sword *Argent*, Mounted on a *Barbed Courſe* of the Second, for the Dukedom of *Latuania*. Its chief Cities are *Cracovia*, *Warſovia*, *Damzerk*, *Vilna*, *Kion*, *Cameneca*, and *Smolenſco*; and Rivers are *Viſtula*, *Niemen*, *Dunæ* and the *Boriſthenes*. §. 2. *Europe.*

Hungary is bounded Eaſt with *Tranſilvania*, and *Walachia*, Weſt with *Stiria*, *Auſtria* and *Moravia*, North with the *Carpathian* Mountains, and South with *Sclavonia* and part of *Dacia*. The People are valiant, and ſhew their Antiquity to be *Scythians* by their barbarous Manners, and neglect of Learning Their Sons equally inherit without Priviledge of Birthright, and their Daughters portion is only a *New Attire*. Its Commodities are *Colours*, *Wheat*, *Beef*, *Salt*, *Wine* and *Fiſh*, the *German Emperour* and *Turk* hath it between them. The Arms is eight Barrs *Gules*, and *Argent*, they are ſome of the *Romiſh*, and others *Mahometans*. There are two *Archbiſhops*, and thirteen *Biſhops*, and its chief Cities are *Tranſilvania*, *Valaſtia*, *Moldavia*, *Buda*, *Presbrough*, *Hermonſtada*, *Tergoguis*, *Czuchan*, *Craffa* and *Bargos*. Its Rivers are the *Drin*, *Oxſeus*, *Peneus*, *Vardax*, *Marize* and the *Danubus*.

§. 2. *Sclavonia* is bounded South with the *Adriatick Seas*, Eaſt with *Greece*, North with *Hungary*, and Weſt with *Carniola*. It is fruitfull of all thoſe Commodities found in *Italy*, and is under ſeveral Governments, *viz. Turks*, *Venetians*, *Hungarians* and *Auſtrians*. The Arms are *Argent*, a Cardinals *Hat*, the ſtrings *Pendant*, and Pleated in a True-lovers-knot, meeting in the Baſe *Gules*. They are ſome *Chriſtians*, and ſome *Mahometans*. There are four *Archbiſhops*, and twenty ſix *Biſhops*. Its chiefeſt Cities are *Nova*, *Zara*, *Nonigrad*, *Tinu*, *Sebenico*, S. *Nicolo*, *Trau*, *Spalato*, *Salona*, *Almiſſe*, *Starigrad*, *Veſicchio*, *Catara*, and *Doleigne*.

Europe.

Dacia is bounded Eaſt with the *Euxine Seas*, on the Weſt with *Hungary* and *Sclavonia*, North with *Podolia*, and South with *Thrace*, and *Macedonia*. The Soyl is fruitfull in *Corn* and *Wine*. It yieldeth medicinal *Plants*, they have plenty of *Fowls*, both wild and tame, very Populous and of Nature like the *Hungarians*; they are all *Mahometans*; Its moſt famous Cities are *Triſte* and *Pedena*.

Greece is bounded Eaſt with *Propontick Helleſpont*, and *Ægean Seas*, Weſt with the *Adriatick*, North with *Mount Hæmus*, and South with the *Ionian Seas*. It was once the Mother of Arts and Sciences, but now the very Den of the *Turkiſh Empire*. The Soyl is very fruitfull if well manur'd, which made the Poet ſay——

Impius hæc tam culta novalia miles habebit?
Barbarus has ſegetes? en queis conſevimus arva

Its Commodities are *Gold*, *Silver*, *Copper*, C

lours, *Wines*, *Velvets*, *Damask*; here is the Mount of *Parnassus*: Here was the *Temple* of *Delphos*, consecrated to *Apollo*; where the *Devil* through the *Oracle* did deceive the People, but after the Crucifixion of *Christ* the *Oracle* ceased. *Augustus* (saith *Suidas*, in whose time *Christ* was born) consulting with the *Oracle*, received this Answer——— §. 2. *Europe.*

Παῖς ἑβραῖς κέλεται μὲ θεοῖς μακάρεσσιν ἀνάσσαν
Τόν δὲ δόμον προλιπεῖν καὶ ἀΐδην αὖθις ἰκέσθαι,
Λοιπὸν ἄπιθι σιγὼν ἐν βωμῶν ἡμετέρων.

An Hebrew Child, whom the blest Gods adore,
Hath bid me leave these Shrines, and pack to Hell,
So that of Oracle I can no more:
In silence leave our Altar, and farewell.

Their Religion is mixt but they are chiefly *Mahometans*. The Arms of this Empire were *Mars* a Cross, *Sol*, between four *Greek Beta's* of the second; *Bodin* saith the four *Beta's* signified Βασιλεὺς, Βασιλήων, Βασιλεύων, Βασιλεῦσι.

The most famous Cities in *Greece* are *Buda*, *Salonique*, *Adrianopolis*, *Scutary*, *Durazzo*, *La Valone*, L'*Armiro*, *Brevezza*, *Larta*, *Lepanto*, *Setines* or *Athens*, *Thebes*, *Corinth*, *Patras*, *Misira* or *Lacædomia*.

I shall pass over the Islands of *Sicily*, *Sardinia*, *Candia* and *Corsica*: and thus we have finished the description of the first part of the World, called by the Name of *EUROPE*.

§. 2.

Aſia.

A S I A.

A S I A the ſecond part of the World is bounded on the North with the *Northern Ocean*; South, with the *Red Sea*; Eaſt, with the *Eaſt Indian Ocean*; and on the Weſt with the Flood *Tanais*. It is bigger than *EUROPE*, or *AFRICA*, and is far more rich, *Viz.* in *Pretious Stones*, and *Spices*, and hath been renowned by the firſt and ſecond *Monarchs* of the *World*. Here Man was Created, placed in *Eden*, ſeduced by *Satan*, and redeemed by our *Bleſſed Saviour*. In it was done moſt of the Hiſtory mentioned in the *Old Teſtament*. It hath been Ruled by the Kings of *China*, of *Perſia*, the *Great Turk*, and the Emperour of *Ruſhia*, and contains theſe Provinces. *Viz. Anatolia*, *Cyprus*, *Syria*, *Paleſtine*, *Arabia*, *Chaldea*, *Aſſyria*, *Meſopotamia*, *Turcomania*, *Media*, *Perſia*, *Tartaria*, *China*, *India* and the *Oriental Iſles*.

Anatolia is bounded Weſt with the *Thracian-Boſphorus*, *Heleſpont* and the *Ægean Seas*; Eaſt with *Euphrates*; North with the *Black Sea*; and South with the *Rhodian*, *Lydian* and *Pamphylian Seas*. Its length is 630, and breadth 210 miles; the Air is ſound, the Soil fruitfull, but in ſome places deſolate: it is inhabited by *Greeks* and *Turks*. It hath theſe Cities of note. *Viz. Anatolia*, *Bruce*, *Chiontai*, *Augoure*, *Trebiſond*, *Sattalie*: and Rivers are *Alie*, *Jordan*, *Euphrates*, and *Tygris*.

Syprus

Syprus is bounded all round with the *Syrian* and *Sicilian Seas*; whoſe length is 200, and compaſs 550 miles. It is ſtored with plenty of all things, ſo that it wanteth no help of other Nations. Its Commodity is *Wine*, *Oyl*, *Corn*, *Sugar*, *Cotton*, *Honey*, &c. for which plenty of all things 'twas Conſecrated to *Venus*, as *Ovid* ſaith : §. 2. *Aſia.*

Feſta dies Veneris, tota celeberrima Cypro,
Venerat ; *Ipſa ſuis aderat* Venus *aurea feſtis.*

The People are *Warlike*, *Strong* and *Nimble*, and very hoſpitable to Strangers Their Arms are Quarterly. 1. *Argent*, a Croſs, Patent, betwixt 4 Croſſes *Or*. 2. Croſs-wiſe of 8 pieces *Argent*, and *Azure*, ſupporting a *Lion Paſſant*, *Azure* Crown'd *Or*. 3. A Lion *Gules*. 4 *Argent* a *Lion Gules* : they are of the *Popiſh* Religion, and have 2 *Archbiſhops* and 6 *Biſhops*.

Syria is bounded Eaſt with *Euphrates*; Weſt with the *Mediterranean Seas*; North with *Cilicia*; and South with *Paleſtine* and *Arabia*. Its length is 525 miles, and breadth 470. They are inhabited by *Mahometans*, *Chriſtians*, and *Pagans*. They are a ſtout and warlike people. In this Countrey there are ſaid to be Sheep whoſe Tails weigh ſome 30, and ſome 40 pounds ; the Peop'e are alſo *gluttenous*; it is almoſt overrun by the *Turks* : Its moſt famous Cities are *Aleppo*, *Te*, *Tripoly* and *Damal*.

Paleſtine is bounded Weſt with the *Mediterranean Seas*; Eaſt with the *Arabian Deſarts*; North with the *Anti-Libianus*; and South with *Arabia*. The Inhabitants are of a *middle ſtature*,

§. 2. *ſtrong conſtitution*, yet a *ſtiffe necked* and *murmuring People* and *Idolaters*. In this is the Land of *Canaan*, and the famous City *Hieruſalem*, tho' now a *Den* of *Idolatrous Mahometans*. It abounds with all good things.

Aſia.

Arabia is bounded Eaſt with *Chaldea* and the *Gulph* of *Perſia*; Weſt with *Paleſtine*, *Ægypt*, and the *Red Sea*; North with *Euphrates*; and South with the *Southern Ocean*. The Inhabitants are *Mahometans*. *Job*'s Habitation was here. It yields *Frankincenſe*, *Pretious Stones*, &c. It is now under the *Great Turk*'s Sceptre. The moſt famous Cities are *Herac*, *Ava*, *Medina*, and *Mectar*: and it hath the famous River *Cayban*.

Chaldea is bounded Eaſt with *Suſiana*; Weſt with *Arabia Deſerta*; North with *Meſopotamia*; and South with the *Perſian Bay*. The Country is exceeding fruitfull; in it is ſuppoſed to have been the Garden of *Eden*; they were great *Southſayers*, and therefore flouted by the *Satyriſt*.——

Chaldeis ſed major erit fiducia, quicquid
Dixerit Aſtrologus, credent à fonte relatum
Ammonis, &c.

The Inhabitants are *ſtout* and *valiant*; they are *Mahometans*. Here *Julian* the *Apoſtate* breathed his Soul out to *Satan*, in theſe dying words,—— *Viciſti tandem Galileæ*: the chief Cities are *Babylon*, *Bagdad*, *Balfora*, and *Sipparum*, with the famous River *Fazze*.

Aſſyria is bounded Eaſt with *Media*; Weſt with *Meſopotamia*; South with *Suſiana*; and North with *Turcomania* and *Chaldea*. This is a very

very plain and level Countrey, and very fruitfull, having good Rivers: the Natives are brave ſtout Warriours, formal in their Habit. It is under the *Turk*'s command, and governed by one of his *Baſſa*'s; who is able to bring into the Field at any time 100000 Souldiers: here are alſo a Sect of the *Neſtorians*, and fifteen *Chriſtian Churches*: its moſt famous Cities are *Calach*, *Cittace*, and *Arbela*. §. 2. *Aſia.*

Meſopotamia is bounded Eaſt with the River *Tigris*; Weſt with *Euphrates*; North with *Mount Taurus*; and South with *Chaldea*, and *Arabia Deſertæ*. It aboundeth with all good things neceſſary for the life of Man; they are *Mahometans*, and a people unable to defend themſelves but by the aſſiſtance of their Neighbours: It belongs to the *Mahometan Empire*. Its chief Cities are *Edeſſa*, and *Cologenbar*. I ſhall not deſcribe *Mount Taurus*, becauſe it is of no moment.

Turcomana is bounded Eaſt with *Media* and *Mare Caſpium*; Weſt with the *Euxine Seas*, *Cappadocia*, and *Armenia major*; North with *Tartaria*; and South with *Meſopotamia* and *Aſſyria*. It is a very mountainous Countrey; the people are handſome, ſtout and brave Warriours: the Women are good Archers. It hath *Gold* and *Silver Mines*: It yields *Grain*, *Fruit* and *Wine*; and in *Colchis* (a part thereof, and in *Aſſyria*) they ſell their Children: The Arms are the *Half Moon Or*. It is inhabited by *Mahometans*, and under the *Turkiſh Empire*. Its chief Cities are *Muſol*, *Bagded*, *Batſora*, *Sanatopdy*, and *Derbent*; with the famous River *Arais*.

Media

§. 2. *Media* is bounded Eaſt with *Parthia*; Weſt with *Aremenia*; North with *Mare Caſpium*; and South with *Perſia*. The Countrey is of a large extent and very different, even to a Miracle, for in the North part it is cold and barren, their Bread is dryed *Almonds*, and Drink the Juice of *Herbs* and *Fruits*. Their Food is *Veniſon*, and other Wild Beaſts, which they catch by hunting. And in the South ſide the Country is of a rich Soil, plentifull in *Corn*, *Wine*, &c. They have been brave Warriours, and it was a cuſtom with them to poyſon their Arrows, in an Oyl called *Oleum Mediacum*: they are *Mahometans*.

Aſia.

Perſia is bounded Eaſt with *India*; Weſt with *Media*, *Aſſyria*, and *Chaldea*; North with *Tartaria*; and South with the *Southern Ocean*. This is a mighty rich Countrey governed by the *Sophy*, the people are ſtrong and valiant, and though *Mahometans*, yet they War with the *Turks* for the *Mahometan Religion* in expounding the *Alcoran*. From hence comes *Bezoars* and other pretious Stones, *Pearls*, and *Silk Works*. It hath theſe famous Cities with *Media*: Viz *Taurus*, *Gorgia*, *Cogſolama*, *Hyſphan*, *Erat*, *Sus*, *Schiras*, and *Ormutz*: and theſe Rivers *Tiriditiri*, and *Bendimuz*.

Tartary bounded Eaſt with *China*, the *Oriental Ocean*, and the Straits of *Anian*; Weſt with *Ruſſia* and *Podolia*; North with the *Frozen Ocean*; and South with *China*. Now the *Tartarians* are divided into certain *Collonies*, and differ in manners and Trade of Living, and are Men of a Square Stature, broad Faces, and look a Squint; they are hardy and valiant; they will eat

eat either Horſe-fleſh or Man's Fleſh. They drink Blood and Mares-milk; their Habit is very homely; they are ſome *Mahometans*, and ſome *Pagans*; their chief Commodity is rich *Furrs*, and they are governed by the great *Cham* of *Tartary*, and hath theſe famous Cities, *viz. Zahaſp*, *Samarcanda*, *Thibet*, *Cambalu* and *Tatur*; and Rivers famous are *Joniſcoy*, *Oby*, *Chezel* and *Albiamu*. §. 2. *Aſia.*

China is bounded Eaſt with the *Oriental Ocean*; Weſt with *India* and *Cathay*; North with *Altay* and the *Eaſtern Tartaries*; and South with *Canchin-China*. It hath 591 *Provinces*, 1593 *Walled Towns*, 1154 *Caſtles*, 4200 *unwalled Towns*, and ſuch an infinite Number of *Villages*, that the whole Countrey ſeems as one *Town*. It is reported that the *Prince* can bring into the Field 300000 Foot and 200000 Horſe. The Land is fruitfull in *Grain*, full of wild and tame *Beaſts*, it yields *Silk*, *Pretious Stones*, *Gold*, *Copper*, &c. The People are ingenious and great Artiſts, Witneſs their *Wagon* made to ſail over the Land driven by the Wind: and Hiſtorians tells us, that the Art of *Printing* and of making *Guns*, is more Ancient with them than with us. They are *Idolaters* and worſhip the *Sun*, *Moon* and *Stars*, alſo they worſhip the *Devil* himſelf, that he may not hurt them. And it hath theſe moſt famous Cities, *viz. Paguin*, *Quinjay*, *Caneun*, *Macao*, *Mancian* and *Magaia*, with the great River *Quinam*.

India is bounded Eaſt with the *Oriental Ocean*, and part of *China*; Weſt with the *Perſian Empire*; North with *Mount Taurus*; and South with the *Indian Ocean*. This Countrey hath an Exact

§. 2. *Aſia.* Exact temperature of Air; two *Summers* and a double encreaſe, bleſt with all things neceſſary for the Life of Man. It hath Mines of *Gold* and *Silver*, *Pretious Stones*, *Spices*, and *Medicinal Druggs*, abundance of *Cattle*, and *Cammels*, *Apes*, *Dragons*, *Serpents*, alſo multitude of *Elephants*; a Creature of a vaſt Bigneſs, ſome of which are ſaid to be nine *Cubits* high, and as many long, and five *Cubits* thick. It is a Creature of wonderfull Sence: for 'tis reported of the *Elephant* on which King *Phorus* ſate in the Warrs of *Alexander*, finding his Maſter ſtrong and luſty, ruſhed boldly into the thickeſt of the Enemies Army: But when he once perceived him to be faint and weary, he withdrew himſelf out of the Battel, kneel'd down, and into his own *Trunck* received all the Arrows, directed at his Maſter. It alſo is of a moſt prodigious ſtrength, for it is reported to carry a *Wooden Tower* on his Back, with thirty fighting men beſides the *Indian* that Rules him. The Sea yields variety of *Pearls* and *Fiſh*; here is alſo the *Leviathan* or *Whale*, of which *Pliny* ſays there are ſome of 960 Foot long; here is the *Rhinoceros* alſo found: (ſuch as hath of late been publickly ſhewed at the *Bell-ſavage Inn* on *Ludgate-hill* in *London*) a deadly and cruel Enemy to the *Elephant*, for though he be leſs, yet he will whet his horn againſt the *Rocks*, and then therewith ſtrive to rip up the *Elephants* Belly, and is by many Naturaliſts ſuppoſed to be the *Unicorn*, for all the parts of his Body, eſpecially his Horn, is a ſoveraign Antidote againſt Poyſon. This Countrey is inhabited by *Indians*, *Moors*, *Arabians*, *Jews*,

Jews, *Tartars* and *Portugeze*. The Natives are *Tawny*, *tall* and ſtrong, and very punctual to their word. They eat no *Fiſh* nor *Fleſh*, but live on things without life; being *Pythagoreans*. It is alſo reported that when the Husband dies, and is burning on the Funeral Pile, that then the Wife leaps into the Fire, and ſo the living and the dead burn together, which made the Poet ſay——— §. 2. *Aſia.*

Et certamen habent lethi, quæ viva ſequatur,
Conjugium; pudor eſt non licuiſſe mori.
Ardent victrices, & præbent pectora flammæ,
Imponuntque ſuis ora peruſta viris.

In *India* theſe are the chief Cities, *viz.* *Amedabur*, *Cambaia*, *Gouro*, *Diu*, *Bengala*, *Pangab*, *Agra*, *Goa*, *Calicut*, *Viſnagor*, *Pegu*, *Arracan*, *Malaca*, *Camboge*, and *Faefo*. The faireſt Rivers are *Indus*, *Ganges* and *Mecon*.

The *Oriental Iſlands* are theſe, *viz.* 1. *Japan*, 2. The *Phillepinæ Iſles*, 3. The *Maluccoſe*, 4. *Bantam*, 5. The *Selebes*, 6. *Borneo*, 7. The Iſles of *Java*, 8. *Sumatra*, 9. *Zeiland*, and other leſſer Iſles of which we ſhall not treat.

1. *Japan* is a rich Iſland abounding with *Gold*: So that *Paulus Ventius* ſaith, that in his time the King's Palace was covered therewith. It is a Mountainous Countrey, a healthfull Air; here the Wheat is ripe in *May*. It's full of Woods of tall *Cedars*, abundance of *Beaſts*, Wild and Tame; and alſo *Fowls*. The Inhabitants are *ſtrong*, and *witty*, and have but one Language. They are *Chriſtians*, and *Idolaters*, and the chief Cities are theſe, *viz.* *Bungo*, *Meaco* and *Sacay*.

The

§. 2. *Aſia.* The *Phillipine Iſles* are in Number 40, called ſo in honour to *Philip* II. King of *Spain*, and are now inhabited by the Natives, and *Spaniards*, they are in a good Air and ſtored with rich Commodities; and in them are theſe Cities, *Luſor*, *Manille*, and *Mindanao*.

The *Moluccoes* Iſlands are many in Number, their Commodity is *Cinnamon*, (which grows in whole Woods; it is the Bark of a Tree, ſtript and laid in the Sun till it looks red; and in three years time the Tree receives his Bark again.) *Ginger*, *Nutmegs*, *Maſtick*, *Aloes*, *Pepper* and *Cloves:* now the *Clove* groweth on a Tree like a *Bay Tree*; yielding bloſſoms firſt white, then green, and at laſt red and hard, and then are Cloves. In it is alſo found the Bird of *Paradice*, and no where elſe, which for the ſtrangeneſs and fairneſs of Feathers exceeds all the Birds in the World. The People are *Pagans*. Here is a *Mountain* of a prodigious height, above the Clouds, and agreeing to the Element of Fire, which it ſeems to mount unto, through Flames, wherewith, a dreadfull Thunder, and a dark Smoak it ſends forth continually.

The Iſles of *Bantam* are in Number ſeven, one of which is continually burning, the Inhabitants are *Barbarous*, *Weak of Bodies*, *Slothfull*, *Dull*, and lying moſt confuſedly together, without Rule, and are *Mahometans*. Its Commodities are *Nutmegs*, and both the *yellow and white Saunderſes*. Now the *Nutmeg* grows on a Tree like a *Peach Tree*, the innermoſt part of whoſe Fruit is the Nutmeg, and is covered over with a Coat which ripe is called *Mace*; they yield their Fruit thrice in the Year, to wit, at *April*, *Auguſt* and *December*. The

The *Selebes* are a Number of Iſles full of *Barbarous* People, and *Man-Eaters*, they have abundance of ſtrange Birds: It yields *Sugar*, *Cocanuts*, *Cloves*, *Oranges*, &c. In ſome of theſe Iſles they make *Bread* of the *Pith*, and *Drink* of the Juice of the Tree called *Sagu*: It hath theſe chief Towns, *viz. Senderem* and *Macaſſar*. §. 2. *Aſia.*

Borneo lieth Weſt of the *Celebes*, and is in compaſs 2200 Miles, the Countrey yields *Aſſes*, *Oxen*, *Herds of Cattle* and *Horſes*. It yields *Camphire*, *Agarick*, and *Mines* of *Adamants*: They think the *Sun* and *Moon* to be *Husband* and *Wife*, and the Stars *their Children*, they reverently ſalute the *Sun* at his firſt riſing. Their Affairs of State they Treat of in the Night, at which time the *Councellor of State* meets, and aſcends ſome Tree, viewing the Heavens till the *Moon* ariſeth, and then they go to their *Houſe of State*. In it are theſe Towns, *viz. Borneo*, *Taiopura*, *Tamaoratas*, *Malno* and *Sagadana*. It is under the Government of the Kings of *Borneo* and *Laus*; the People are *Idolaters*.

Java Major, and *Java Minor*, are two Iſlands oppoſite to *Borneo*. They have plenty of *Fruits*, *Grains*, *Beaſts*, *Fiſh* and *Fowls*, *Gold* and *Pretious Stones*. The Natives are of a middle Stature, broad faced and tawny, their Religion *Mahometans*, and they will eat their neareſt of kin: the chief Town is *Panarucan* near a burning Hill, which in 1586 broke forth, and caſt huge Stones into the City for three Days together, and deſtroyed much People. From the top of this vaſt high Mountain the *Devil* environed with a white and ſhining Cloud, doth ſometimes ſhew himſelf unto his Worſhippers, which live about thoſe Hills. *Su-*

§. 2. *Asia.*

Sumatra lieth North of *Java Major*, betwixt it and the ſtraits of *Sincapura*, its length is 900 Miles, and breadth 200; it is full of Fenns and Rivers, with thick Woods, and hath a very hot Air; it is not fruitfull in *Grain*. Its Commodities are *Ginger*, *Pepper*, *Agarick*, *Caſſia*, *Wax*, *Honey*, *Silk*, *Cotten*, *Iron*, *Tinn* and *Sulphur*. It hath alſo Mines of *Gold*, and is ſuppoſed to be *Solomon's Ophyr*. The King's Furniture of his Houſe, and Trapping for his *Elephants* was beaten *Gold*, and he intituleth himſelf King of the *Golden Mountains*. Here is the notable Mountain *Balalvanus*, ſaid to burn continually; out of which or not far off do ariſe two Fountains, the one is ſaid to run *pure Oyle*, and the other *Balſamum Sumatra*; the People are *Mahometans*. The chief City and Seat of the King is *Achen*, beautifyed with the Royal Pallace, to which you paſs through ſeven Gates one after another, with green Courts betwixt the two outermoſt; which are guarded with *Women*, that are expert at their Weapons, and uſe both *Sword* and *Guns* with great dexterity, and are the only Guard the King hath for his Perſon. The Government is *Abſolute* and *Arbitrary*, merely at the King's pleaſure.

Zeiland lies Weſt of *Sumatra*, it is a good Soyl, and yields theſe Commodities, *viz. Cinnamon*, *Oranges*, *Lemmons*, moſt delicate fruit, *Gold*, *Silver* and *Pretious Stones*, it's full of *wild and tame Beaſts*, *Fiſh and Fowls*, yet deſtitute of the *Vine:* the People are ſtrong and tall, given to *Eaſe* and *Pleaſure*, and are in general *Mahometans*. The chief Towns are *Candia*, *Ventane*, and

and *Janaſipata*. They have Fiſh-ſhells paſſing currant for money, there are other leſſer Iſles which we do for brevity ſake omit, and thus we have done with the deſcription of the ſecond part of the World called *A S I A*. §. 2. *Aſia.*

A F R I C A. *Africa.*

A F R I C A the third part of the World is bounded Eaſt with the *Red-Sea*; Weſt with the *Atlantick-Ocean*; South with the *Southern-Ocean*; and North with the *Mediterranean Sea*; and contains theſe Provinces, *viz. Egypt*, *Barbary*, *Numidia*, *Lybia*, *Terra-Nigritarum*, *Æthiopia-ſuperior* and *Æthiopia-inferior*, with the *Iſlands* thereto belonging. Its Commodities are *Balm*, *Ivory*, *Ebony*, *Sugar*, *Ginger*, *Dates*, *Myrrh*, *Feathers*, &c.

Egypt is bounded Eaſt with *Idumea*, and the Bay of *Arabia*; on the Weſt with *Barbary*, *Numidia*, and *Lybia*; North with the *Mediterranean Sea*; and South with *Æthiopia-ſuperior*. Its length is 562 Miles, and breadth 160. The Natives are of a *Tawny* Complection, their Wives are the Merchants, whilſt the Husband attends the Houſhold Affairs. They were the Inventers of *Mathematical Sciences*; they were alſo *Magicians*, and are ſtill endued with a ſpecial Dexterity of Wit: They worſhip in every Town a particular God, but the God by them moſt adored was *Apis*. This Land is very fruitfull

§. 2. *Africa.* in all manner of *Cattle*, *Cammels*, and abundance of *Goats*; they have plenty of *Fowls* both wild and tame: It hath *Metals* and *Pretious Stones*, *Good Wines* and rare Fruits, as *Oranges*, *Lemmons*, *Cittons*, *Pomgranets*, *Figgs*, *Cherries*, &c. Here alſo groweth the *Palm-Tree*, which grow the *Male* and *Female* together; both put out *Cods* of Seeds, but the Female is not fruitfull unleſs ſhe grow by the Male, and have her Seed mixt with his. The *Pith* of this Tree is good for *Sallads*, of the Wood they make *Bedſteads*, of the *Leaves Baskets*, *Mats*, and *Fanns*, of the outward husk of the fruit *Cordage*, of the inward *bruſhes*. Its fruit is the *Dates*, good for food, and finally 'tis ſaid to produce all things neceſſary for the Life of Man, and its Branches are worn in token of *Victory*, as ſaith *Horace*.

——*Palmaque nobilis,*
Terrarum Dominos evehit ad Deos.

It hath many other Rarities which I am forc'd to omit. In it are theſe famous Cities, *viz.* *Sabod*, *Cairo*, *Alexandria*, *Raſcha*, *Damietta*, *Coſir* and *Surs*, with the famous River *Nilus*, which by its overflowing makes the Land fertile, according to that of *Lucia*.——

Terra ſuis contenta bonis, non indiga mercis,
Aut Jovis; in ſolo tanta eſt fiducia Nilo.

Barbary is bounded Eaſt with *Cyrenaica*; Weſt with the *Atlantick-Ocean*; North with the *Mediterranean*, the Straits of *Gibralter*, and part of the *Atlantick-Ocean*; and on the South by *Mount-*

§. 2.

Africa.

Mount Atlas. It is full of *Hills* and *Woods*, ſtored with *Wild Beaſts:* as *Lyons, Bears,* &c. *Large Herds* of *Cattle*; it hath *Dragons, Leopards,* and *Elephants*; beautifull, ſwift, and ſtrong *Horſes*; it is the fruitfulleſt Countrey in the World in ſome parts of it; for *Pliny* ſaith that not far from the City *Tacape*, you ſhall ſee a great *Palm-Tree* overſhadowing an *Olive*; under that a *Figg-Tree*; under that a *Pomgranat*; under that a *Vine*; and under all *Peaſe, Wheat* and *Herbs*; all growing and flouriſhing at one time, which the Earth produceth of it ſelf: Its length is 1500 Miles, and breadth 300 Miles, the Natives are of a *Tawnyiſh Colour, rare Horſemen, crafty* and *unfaithfull*, and above meaſure *Jealous* of their *Wives*. It contains theſe Kingdoms, *Viz. Tunis, Algiers, Morocco* and *Feze*, and it hath theſe *Iſles, Viz. Pantalaria, Carchana, Zerby, Gaulos* and *Malta*, the two latter of which Iſles are inhabited by *Chriſtians*, and are of the *Romiſh* Religon; but for the other parts of *Barbary*, they are either *Mahometans* or *Pagans*. The moſt famous Cities are *Morocco, Feze, Tangier*, (which formerly was a Principal City of *Barbary*; but is now demoliſht and lain level with the Ground, by the Command of His late *Majeſty Carolus* II. of bleſſed Memory, and performed by the indefatigable skill and induſtry of the right *Honourable George Lord Darmouth Anno*, 1683.) *Teleuſin, Oran, Algier, Conſtantine, Tunis, Tripoly* and *Barca*, with theſe famous Rivers, *Ommiraby* and *Magrida*.

Mount Atlas is a ridge of Hills of no ſmall length, but of an exceeding heighth, above the Clouds, and is always covered with *Snow*,

§. 2. *Summer* and *Winter*, full of thick Woods, and againſt *ASIA* ſo fruitfull, that it affords excellent Fruit of it's natural growth; it received it's Name from *Atlas* a King of *Mauritania*, fained by the Poets to be turned into that Hill, by the Head of *Meduſa*; he was feigned to be ſo high that his Head touched Heaven: The ground of this Fiction I ſuppoſe was from his extraordinary knowledge in *Aſtronomy*, which *Virgil* ſeems to intimate——

Africa.

Jamque volans apicem & latera ardua cernit
Atlantis duri, Cælum qui vertice ſoluit.

Numidia is bounded Eaſt with *Egypt*; Weſt with the *Atlantick-Ocean*; North with *Mount Atlas*; and South with *Libia Deſerta*. The Natives are a wandring and unſtable People, for they ſpend their Lives in Hunting, and continue not above four or five Days in one place, but ſo long as it will graze their *Camels*. Here grow abundance of *Dates*, with which they feed themſelves, and with the Stones fat their *Goats*. The Air here is ſo ſound that it will cure the *French-Pox* without any Courſe of *Phyſick*. They are *Mahometans*: its chief Provinces are *Dara*, *Peſcara*, *Figbig*, *Tegorarin* and *Biledulgerid*; and its chief Cities are *Tavadath*, *Dara* and *Zeb*; they belong to the Scepter of *Morocco*.

Lybia is bounded North with *Numidia*; Eaſt with *Nuba*; South with *Terra-Nigritarum*; and Weſt with *Gualata*. This is well termed a Deſart, for in it may a man travel eight or ten Days and not ſee any Water, nor Trees;

Trees, nor Graſs So that Merchants are forced to carry their Proviſion with them on *Camels*, which if it fails they kill their *Camels*, and drink the Juice of their Entrails It contains theſe Provinces, *Viz. Zahaga*, *Zvenziga*, *Targa*, *Lembta* and *Bordea*. They are governed by the chief of the *Clans*, and are a People only differing from *Brute-Beaſts*, by their Shape and their Speech. §. 2. *Africa.*

Terra Nigritarum is bounded Eaſt with *Ethiopia-ſuperior*; Weſt with the *Atlantick-Ocean*; North with *Lybia*; and South with the *Ethiopick-Ocean*. The Countrey is under the *Torrid-Zone*, full of People, and moſt exceſſive hot; the ſoyl is exceeding fruitfull, brave Woods, Multitudes of *Elephants* and other *Beaſts*: they have Mines both of *Silver* and *Gold*, very fine and pure; the Natives are *Cole-Black*, or very *Tawny*, and are now ſome of them *Mahometans*, but moſt of them *Pagans*. It hath now theſe Provinces, *Viz. Ora*, *Anteroſa*, *Gualata*, *Agadez*, *Cano*, *Caſena*, *Sanaga*, *Gambra*, *Tombrutum*, *Melli*, *Gheneoa*, *Guber*, *Gialoſi*, *Guinea*, *Benin*, *Guangara*, *Bornum* and *Goaga*, (in which groweth a *Poyſon*, which if any eateth but the tenth part of a Grain it will end his Days) *Bito*, *Temiano*, *Zegzeg*, *Zanfara*, *Gathan*, *Medra* and *Daum*. And in it are theſe moſt remarkable Cities: *Gue*, *Eata*, *Gueneba*, *Tomta*, *Agados*, *Cuſſera*, *Tuta*, *Waver* and *Sanfara*. The Rivers here that are moſt famous are *Sernoga*, *Cambua* and *Rio-Degrand*.

Æthiopia-ſuperior is bounded Eaſt with the Red-Sea, and *Sinus Barbaricus*; Weſt with *Lybia-inferior*, *Nubia*, and *Congo*; North

§. 2. with *Egypt*, and *Lybia Marmarica*; and South with *Monta-Luna*. Now its length is ſaid to be
Africa. 1500 Miles, and Circute 4300. It is under the Command of the *Abaſſine Emperour*: here the Air and Earth is ſo hot and pieircing, that if the Inhabitants go out of their Doors without Shoes they loſe their Feet; here they alſo roaſt their Meat with the *Sun*: they have ſome grain, their Rivers are almoſt choaked up with *Fiſh*, their Woods ſtuffed with *Deer*, yet they will not trouble themſelves to catch them. The Inhabitants are *Lazy* and deſtitute of all *Learning*, they are of an *Olive Tawny*: here is alſo a *Fountain*, that if a man drinks thereof he either falleth mad, or elſe for a long time is troubled with a continual *Drowſineſs*, of which *Ovid* thus ſpeaks——

Æthiopeſque Lacus; quos ſi quis faucibus hauſit,
Aut furit, aut patitur mirum gravitate ſaporem.

And it contains theſe Provinces, *Viz. Guagere*, *Tigremaon*, *Angote*, *Amara*, *Damut*, *Gojamy*, *Bagamedrum*, *Barnagaſſe*, *Dancali*, *Dobas*, *Adel*, *Adea*, *Fatigar*, *Xoa* and *Barus*. Now as for the Government of theſe Empires 'tis merely Regal: here is the Order of St. *Anthony*, to which every Father that is a Gentleman, is to give one of his Sons: out of which they raiſe about 12000 Horſe, which are to be a ſtanding Guard of the *Emperour*'s Perſon: their Oath is to defend the Frontiers of their *Kingdom*, to preſerve *Religion*, and to root out the Enemies of their *Faith*; the Principals of their Religion are theſe. Firſt, they circumciſe their Children both *Males* and

and *Females*. Secondly, they Baptize the *Males* at 40 and *Females* at 80 Days after Circumcision. Thirdly, after the *Eucharist* they are not to spit till Sun set. Fourthly, they profess but one Nature and one Will in *Christ*. Fifthly, they accept but of the three first general Councils. Sixthly, the Priests live by the own labour of their hands, and are not to beg. Seventhly, they baptize themselves every *Epiphany* in *Lakes* or *Ponds*, because that Day they say *Christ* was baptized by *John* in *Jordan*. Eighthly, they eat not of those Beasts which *Moses* pronounced unclean, keeping the *Jews Sabbath*, with the *Lord's Day*. Tenthly, they administer the *Lord's Supper* to *Infants* presently after *Baptism*. Eleventhly, they teach the Reasonable Soul of Man comes by *Seminal Propagation*. Twelfthly, that *Infants* dying *unbaptized* are saved, being sanctifyed by the *Eucharist* in the Womb, and finally they produce a Book of Eight Volumes, writ as they say by the *Apostles* at *Jerusalem* for that purpose, the Contents whereof they observe most solemnly, and thus they differ from the *Papists*. §. 2. *Africa.*

Now the chief Cities in this *Empire* are these, *Viz. Barcne*, *Caxumo*, *Amarar*, *Damont*, *Cefates*, *Narre*, *Goyame*, and *Adeghena* with the famous Rivers *Zaire* and *Quilmanei*.

Æthiopia-inferior is bounded East with the *Red-Sea*; West with the *Æthiolick Ocean*; North with *Terra-Negritarum*, and the higher *Æthiopy*; and South with the *Main Ocean* And it contains these Provinces, *Viz. Zanzibar*, *Monomotapa*, *Cafravia*, and *Manigongo*. The Natives are Black, with curled Hair, and are *Pagans*.

§. 2. In it are great Herds of Cattle, abundance of *Deere*, *Antelopes*, *Baboons*, *Foxes*, *Hares*, *Oſtriches*, *Pelicans* and *Herons*, and in a Word what elſe is neceſſary for the Life of Man. In it are theſe moſt famous Cities, *Viz. Banza*, *Loangà*, S. *Salvador*, *Cabazze*, *Sabula*, *Simbaos*, *Butua*, and *Tete*. The Rivers are *Cuama*, *Spiritus Sancto*, and *Dos Infante*.

Africa.

The Iſlands in *AFRICA* are theſe, *Viz.* the *Æthiopick-Iſles*, *Madagaſcar*, *Socofara*, *Mohelia*, *Mauritius*, St. *Helens*, the *Iſles of Aſcention*, St. *Thomas-Iſles*, the *Princes-Iſles*, the *Iſles of Annibon*, the *Iſles of Cape d' Verd*, the *Canaries*, *Madera*, *Holyport* and the *Heſperides*. The Deſcription of all which I am forced to omit becauſe I have been ſo very large in the Deſcription of the third part of the World called *AFRICA*.

AMERICA.

---

§. 2.

AMERICA.

America.

AMERICA, the fourth part of the World, was firſt diſcovered by *Chriſtopher Columbus*, *Anno* 1492, but it hath received its Name from *Americus Veſputius*, who in the year of Chriſt 1597 did ſail about it. Now this fourth part of the World is bounded Eaſt with the *Atlantick Ocean*; Weſt with the *Weſt-Indian Ocean*; South with the *Magellanick Sea*; and on the North with the *Northern Ocean.*

When firſt the *Spaniards* had entred on *America* they found the people without Apparel, and their Bread was made of the *Jucca-Root*, whoſe Juice is a ſtrong poyſon: but it being ſqueezed out and dried it makes Bread. They worſhipped *Deviliſh Spirits*, which they call *Zema*; in remembrance of which they keep Images made of Cotton Wool, to which they did great reverence, ſuppoſing the Spirits of their Gods were there; and to blind them the more, the Devil would cauſe theſe *Puppets* to ſeem to move and to make a noiſe, ſo that they feared them ſo greatly that they durſt not offend them; which if they did, then the Devil would come and deſtroy their Children. They were ſo ignorant that they thought the *Spaniards* to be immortal; but the doubt continued not long, for having taken ſome of them Priſoners, they put them under Water untill they were dead, and then they knew them to be mortal like

§. 2. *America.* like other Men. They were quite deſtitute of all good Learning, reckoning their Time by a confuſed knowledge of the courſe of the *Moon*; they were honeſt and kind in their Entertainments, encouraged thereunto by an Opinion that there was a certain place to which the Souls of thoſe that ſo lived, and dyed for the defence of their Countrey, ſhould go to, and there be for ever happy. So natural is the knowledge of the Soul's Immortality, and of ſome *Ubi*, for its future reception, that we find ſome tract of it in the moſt *Barbarous Nations*. The *Americans* were of a fair and clear Complexion. This Countrey is very plentifull in *Spices*, and *Fruits*; and ſuch Creatures which the other parts never knew: So full of *Cows* and *Bulls*, that the *Spaniards* kill thouſands of them yearly only for the *Hides* and *Tallow*. Bleſt with abundance of *Gold*, that in ſome Mines they have found more *Gold* than *Earth*. They have *Grey Lyons*, their *Dogs* ſnowted like *Foxes*, neither can they bark; their *Swine* hath *Talons* ſharp as *Razors*, and their *Navel* on the ridges of their *Backs*; the *Stags* and *Deer* without Horns; their *Sheep* are ſo ſtrong that they make them carry burthens of 150 pound weight; they have a Creature with the forepart as a *Fox*, and hinder as an *Ape*, except the Feet which are like a *Man*'s; beneath their Belly is placed a Receptacle like a *Purſe*, in which their young remains till they can ſhift for themſelves, never coming thence but when they ſuck and then go in again. The *Armadilla* is like a barbed *Horſe*, armed all over with *Scales* that ſeem to ſhut and open. The *Vieugue* reſem-

reſembling a *Goat*, but bigger, in whoſe Belly is found the *Bezoar*, good againſt Poyſon. A Hare having a Tail like a *Cat*, under whoſe Skin nature hath placed a *Bagg*, which ſhe uſeth as a *Store-houſe*: for having filled her ſelf ſhe putteth the reſidue of her proviſion therein. *Pigritia*, a little Beaſt that can go no further in fourteen days than a Man will caſt a Stone. For their *Birds* they are of ſuch variety of *Colours* and *Notes*, which are ſo rare and charming, that they ſurpaſs all other *Birds* in any other parts. §. 2. *America.*

Now *America* is divided into two parts, *viz. Mexicana*, whoſe compaſs is ſaid to be 13000 miles, and that other part called *Peruana*, whoſe *Circumnavigation* is eſteemed 17000 miles. The Provinces of *Mexicana* are theſe: Viz *Eſtotilant*, *Canada*, *Virginia*, *Florida*, *California*, *Nova-Gallicia*, *Nova-Hiſpania*, and *Guatimala*. *Peruana* contains theſe *Provinces: viz. Caſtella-Aurea*, *Nova-Granado*, *Peru*, *Chile*, *Paragnay*, *Braſila*, *Guiana*, and *Paria*. To *Peruana* belongs theſe principal Iſles: *viz. Hiſpaniola*, *Cuba*, *Jamaica*, *Porto-Rict*, *Barbadoes*, the *Charibe-Iſles*, *Inſula-Margaretta*, *Molaqus-Iſles*, *Remora*, *Inſula Solamnis*, and ſome other ſmall Iſles. But firſt of *Mexicana*.

Eſtotilant hath on the Eaſt the *Main Ocean*; South *Canada*; Weſt *Terra Incognita*; and North *Hudſon's Bay*. It comprehends *Eſtotilant*, ſo principally called, *Terra Corterialis*, *New-found-land*, and the Iſles of *Baccalaos*. It is well ſtockt with all things neceſſary for the life of Man: the Natives are barbarous, fair, ſwift of Foot, and good Archers. They are *Pagans*.

Canada

§. 2. *Canada* is bounded North with *Cortelialis*; South with *New England*; Eaſt with the *Main Ocean*; and Weſt with *Terra Incognita*. It contains theſe ſeveral Regions: *viz. Nova Francia*, *Nova Scotia*, *Norumbegne*, and four ſmall *Iſles* adjoyning thereto. The people when firſt diſcovered were very rude and barbarous, going Naked only a piece of Fiſhes Skin to cover their private parts, and had two or three Wives a piece, which never Marry after the death of their Husbands The Soil is fruitfull, and yields all manner of good things Here groweth the *Sea Horſe* whoſe Teeth is an *Antidote* againſt *Poyſon* It hath theſe principal Cities: *viz. Hochelaga* and *Quebeque*.

America.

Virginia hath North *Canada*; South *Florida*; Eaſt *Mare-del-Noort*; Weſt with *Terra Incognita*. And it is now divided into *New England*, *New Belgium*, and *Virginia* ſtrictly ſo called. It is in ſome parts (yea moſt parts) Mountainous, Wooddy and Barren, and full of Wild Beaſts. It yields plenty of *Cattle*, wild and tame *Fowls*. Its Commodities are *Furrs*, *Amber*, *Iron*, *Rop's*, *Tobaco*, *Sturgeon*, &c. The Natives are but few in number, and thoſe very different both in Speech and Size, to a Miracle: thoſe whom they call *Saſques Honoxi*, are to the Engliſh as Giants clad in *Bears Skins*; thoſe whom they call *Wigcocomici*, are as Dwarfs; for the moſt part without Beards; they hide their nakedneſs with a Skin, the reſt of their Body they paint over in the figures of horrid Creatures The chief Towns are *James's*, and *Plimouth*, and Iſle of *Bermoodus*, which I here omit.

Florida

Florida is bounded North-East with *Virginia*; East with *Mare-del-Noort*; South with the *Gulph* of *Mexico*. It was first discovered by the *English*, *Anno* 1497. The Soil is very fertile in Grain and Fruit, Beast wild and tame, and so also for Fowls: It yields lofty *Cedars*, and *Sassafras*: It hath *Gold* and *Silver* Mines, and also *Pearls*. §. 2. *America*.

The Natives are of an *Olive-Colour*, strong and fierce, and are clad like the former Natives of *America*. The Women when their Husbands are dead cut off their Hair, and cannot Marry till their Hair is grown out again. To it belongs these Islands: *viz.* the Isles of *Tortugas*, *Martyres*, and *Lucaios*: there are also about 24 small ones more which are insignificant. The Women here are most extreamly beautifull; the Natives are *Pagans*. Its chief Towns are St. *Helens*, *Ax Carolina*, and *Port-Royall*.

California is an Island having on the West *New Spain*, and *New Gallicia*; and so unto those undiscovered parts which lie furthest North, to the Straits of *Anian*; and 'tis divided into these four parts: *viz.* *Quivira*, *Cibola*, *California*, specially so called, and *Nova Albion*. All which Countreys are indifferent fruitfull, full of Woods, and both wild and tame Beasts; plenty both of Fish and Fowl wild and tame: They worship the *Sun* as their chief God: They go naked both Men and Women in some parts, others are half way cloathed; and so very various that I cannot in this small Tract describe them. Its chief Town is *Chichilticala*. And here I cannot chuse but remark that in *Quivira* their Beasts are of strange forms, and are to them both *Meat*, *Drink* and *Cloathes*.

For

§. 2. For the *Hides* yields them *Houſes*; their *Bones* and *Hair*, *Bodkins* and *Threed*; their *Sinews*, *America.* *Cords*; their *Horns*, *Guts* and *Bladders*, *Veſſels*; their *Dung*, *Fire*; their *Calveskins*, *Buckets* to draw and keep Water in; their *Blood*, *Drink*; and their *Fleſh*, *Meat*; and ſo much for *California.*

Nova Gallicia is bounded Eaſt and South with *Nova Hiſpania*; Weſt with the River *Buena*, *Guia*, and the *Gulph Californica*; and North with *Terra Incognita.* It comprehendeth theſe Provinces: *viz. Chialoa*, *Contiacan*, *Xaliſco*, *Guadalajara*, *Zacatecas*, *New Biſcay*, and *Nova Mexicana.* In which Provinces the Air is indifferently temperate, yet ſometimes given to Thunder, Storms, and Rain. It is full of Mountains, yields *Braſs*, *Iron*, &c. They have plenty of *Fiſh*, *Beaſt*, *Fowls*, *Fruit*, and abundance of *Honey.* The Natives are wavering, crafty and lazy, given to ſinging and dancing. They go not naked: they are ſubject to the King of *Spain.* Its chief Cities are *Guadalajara*, and St. *John*s.

Nova-Hiſpania is bounded Eaſt with the *Gulph* of *Mexico*, and the Bay of *New-Spain*; Weſt with *Nova Gallicia*, and *Mare-del-Zur*; on the North with part of *Nova Gallicia*, and part of *Florida*; and on the South with the *South Sea.* It comprehendeth theſe Provinces: *Viz. Mexicana*, *Mechoacan*, *Panuco*, *Traſcala*, *Guaxata*, *Chiapa* and *Jucutan.* In all which the Air is healthfull and temperate, rich in Mines of *Gold* and *Silver*, *Caſſia*, *Coccineel*, which grows on a ſhrub called *Tuna*, yields grain, and delicate Fruit, *Birds* and *Beaſts* both *Wild* and *Tame*,

Tame : their Harveſt is in *October* and in *May*. §. 2.

The Natives are witty and hardy, yet ſo ignorant that they thought the *Spaniſh-horſe* and *Man* to have been but one Creature, and thought when the Horſes Neighed they had ſpoken. The *Spaniards* whoſe Cruelties will never be forgotten, did in leſs than 17 years kill of the Natives 6000000; here is a Tree called *Meto*, it bears 40 kinds of Leaves, of which they make *Conſerves*, *Paper*, *Flax*, *Mantles*, *Matts*, *Shoes*, *Girdles*; it yields a *Juce* like *Syrup*, which boyled becomes *Hony*, if purified *Sugar*; the *Bark* roaſted is a good *Emplaiſture for Punctures* or *Contuſions*; and it yields a *Gum* Sovereign againſt *Poyſon* : here is alſo a Burning Mountain called *Propæampeche*, which ſends forth two ſtreams the one of *Red* and the other of *Black Pitch*: the Inhabitants are *Pagans*. *America.*

Guatimala is bounded North with *Jacuta*, and the *Gulph Honduras*; South with *Mare-del-Zur*; Eaſt with *Caſtella-Aurea*; and Weſt with *New Spain*. The Soyl and People are as in *Nova Hiſpania* : it contains theſe Provinces, *Viz. Chiapa*, *Verapaz*, *Guatimala*, *Hondarus*, *Niceragna* and *Teragna*. And Towns of moſt Note are *Cutrinidao* and St. *Michael's*, the People are *Pagans*. And ſo much for *Mexicana*.

Peruana the Second Part of *AMERICA*, ſo called from *Peru* a Place of Note therein, and it doth contain theſe Provinces, *Viz. Caſtella-Aurea*, *Nova-Granada*, *Peru*, *Chile*, *Paragnay*, *Braſile*, *Guyana*, and *Paria* and its *Iſles*. But ſuch *Iſles* that fall not properly under ſome of theſe muſt be referred to the general Heads of the *American Iſlands*.

Caſtel-

§. 2. *Caſtella-del Oro*, is bounded East and North with *Mare-del-Noort*; West with *Mare-del-Zur*; *America.* and South with *Granada*. And it containeth theſe Provinces, *Viz. Panama*, *Darien*, *Nova-Andaluzia*, St. *Martha* and *De-la-Hacha*. In all which Provinces the Air is very hot and unhealthfull: the Soyl either Mountainous and Barren, or low and Miry: plenty of Beaſt and Fowls. Here is ſaid to be a Tree which if one touch he is poyſoned to death: the old Natives are now almoſt quite rooted out. Its chief City is *Carthagena*, which Sir *Francis Drake* in 1585 took by Aſſault. This Land hath abundance of *Gold*.

Nova-Granada is bounded North with *Caſtella Aurea*; West with *Mare-del-Zur*; East with *Venezuela*; and South with *Terra Incognita*. Its length is 390 Miles, and as much in breadth. It doth conſiſt of theſe two parts, *Viz. Granada*, ſpecially ſo called, and *Popayan*, both which hath a temperate Air, brave Woods, well ſtored with *Cattle*, and *Fowls* both wild and tame, plenty of *Emeralds* and *Guacum*: the People tall and ſtrong; the Women handſome and better dreſt than their Neighbours: The chief Towns are S. *Foy d' Bagota* and *Popayan*.

Peru is bounded East with the *Andes*; West with *Mare-del Zur*; North with *Popayan*; and South with *Chile*. It is 2100 Miles in length, and its breadth is 300 Miles: it is a Mountainous Country: And here 'tis to be noted that in the Plains it never raineth; and that on the Hills it continually raineth from *September* to *April*, and then breaks up. In the Hilly Countreys the *Summer* begins in *April*, and endeth in

in *September*. In the Plains the *Summer* beginneth in *October* and endeth in *April*. So that a man may travel from Summer to Winter both in one Day; be frozen in the Morning when he setteth out, and scorched with heat before the dawning of the Day. It is not very plentifull of Corn nor Fruits, but they have a kind of Sheep which they call *Pacos* as bigg as an *Ass*, profitable both for fleece and burthen, but in taft as pleasant as our *Mutton*: So subtile that if it be overladen it will not for blows move a foot till the burthen be lessened, and it is a very hardy Creature. Here is a Figg-tree, the North part of which looketh towards the Mountains, and yieldeth its Fruit in Summer only, and the Part facing the Sea in Winter only. They have another Plant, that if put into the hands of the Sick and the Patient looks merry, they will recover; but if sad, die. It yieldeth also Multitudes of Rarities more. It's chief Commodities are *Gold*, *Silver*, *Tobacco*, *Sarsaparilla* and *Balsamum d' Peru*, and many other rich *Drugs*. The Natives are almost now rooted out of the Country. They are fierce and *Barbarous*. Now it contains these *Provinces*: viz. *Quito*, *Los Quinxos*, *Lima*, *Cusco*, *Charcos* and *Collao*. §. 2. *America*.

Chile is bounded North with *Deserta Alacama*; West with *Mare del Zuz*; South with the Straits of *Magellan*; and East with *Rio de la Plata*. Its length is 1500 miles, and breadth uncertain. The Soil hereof in the Mid-land is mountainous and unfruitfull; towards the Sea-side level and fertile; with products of *Maize* and *Wheat*, plenty of *Gold* and *Silver*, *Cattle*

§. 2. *America.* and *Wine.* The Natives are very tall and warlike, ſome of them affirmed to be eleven foot high; their Garments of the Skins of Beaſts; they are of a white Complexion; their Armes *Bows* and *Arrows.* It is divided into *Chile* (eſpecially ſo called) and *Magellanica.* Here Sir *Walter Rawleigh* planted two *Collonies*, who for want of timely Succors were either ſtarved at home, or eaten by the *Salvages*, as they ranged the Countrey for food.

Paraguay is bounded South with *Magellanica*; Eaſt with the main *Atlantick*; North with *Brazila*; and Weſt with *Terra Incognita.* It is ſaid to be of a fruitfull Soyl, well ſtored with *Sugar-Canes*, *Fraught* with Mines of *Gold*, *Braſs*, and *Iron:* great plenty of *Amathyſes*, and *Monkeys*, *Lyons* and *Tigers*, the People are as the other *Salvages*, and it contains theſe Provinces, *viz. Rio de la Plata*, *Tucaman* and *La Crux de Sierra*, and it's chief Towns are *Puenas Agrees*, and *Chividad.*

Brazila is bounded Eaſt with *Mare del Noort*; Weſt with *Terra Incognita*; North with *Guiana*; and South with *Paraguay.* Its ſaid to be 1500 Miles long and 500 broad. The Countrey is full of Mountains, Rivers and Foreſts, the Air ſound and healthfull; the Soyl is indifferent fruitfull: Its chief Commodities are *Sugar* and *Brazele-wood.* There is a Plant called *Copiba* which yields *Balſam*, ſoveraign for Poyſon. An Herb called *Viva*, which if touched will ſhut up and not open till the Toucher is out of ſight. A Creature which hath the Head of an *Ape*, the Foot of a *Lyon*, and the reſt of a *Man.* The *Ox-Fiſh* with *Arms*, *Fingers* and *Duggs*, the reſt

reſt as a *Cow*. So that it may be ſaid of *Braſila*——*Semper aliquid apportat novi.* §. 2.

The people are witty as appears by their ſayings to the Chriſtians (holding up a Wedge of Gold) ſay'd they, *Behold your God oh ye Chriſtians!* on their Feſtival-days they go Naked, both Men and Women; and are able Swimmers, ſtaying under water an hour and half: the Women are delivered without great pain: ſome of the Natives are all over Hairy, like Beaſts: it containeth not Provinces, but theſe Captain-Ships: *viz. Vincent, Rio de Juneiro, Holy Ghoſt, Porto-Seguro, Des Ilheos, Todos los Santos, Fernambuck, Tamaraca, Paraiba, Rio Grande, Saiara, Maragnon,* and *Para*. Its chief Cities are, *Meranhan, Tamaracai,* and *Olinda,* and the great River *Zoyal*. *America.*

Guiana is bounded Eaſt with the *Atlantick*; Weſt with *Mount-Peru*; North with the *Flood Orenoque*; and South with the *Amazones*. The Air here is indifferently good: near the Sea it is plain and level, up in the Countrey Mountainous; here the Trees keep their leaves all the year, with their fruit always ripe, and growing. The Inhabitants are under no ſettled Government: they puniſh only *Murder, Theft,* and *Adultery*; their Wives are their Slaves, and they may have as many as they pleaſe; they are without *Religion* or Notion of a *Deity*. It doth contain theſe Provinces: *viz. Rio de las Amazones, Wiapoce, Orenoque,* and the Iſles of *Guiana*. Its Comodities are *Sugar,* and *Cotton*: in it are plenty of *Beaſt, Fiſh,* and *Fowles*; they are Swarthy in Complection, and great *Idolaters*; as for Cities it hath none of note.

§. 2. *Paria* is bounded on the Eaſt with *Guiana*; Weſt with the Bay of *Venezuela*; North with the *Atlantick Ocean*; and South with *Terra Incognita*: and contains theſe Provinces: *Viz. Cumana, Venezuela*, S. *Margarita*, *Cataiana*, and its Iſles. All which are not very fruitfull; it is well ſtored with Pearls; the People paint their Teeth and Bodies with Colour: The Women are trained up to ride, run, leap and ſwim: and alſo to Till the Land. In it are theſe moſt noted Cities: *Viz.* St. *Jago*, St. *Michael de Nivery*, and *Mahanao*.

America.

As for the Deſcriptions of the *American Iſles* I muſt beg the favour to omit: I ſhall therefore only name them having been ſo very large already; and they are theſe: *Viz. Los. Ladrones*, *Fernandes*, the *Caribes*; as *Granada*, S. *Vincent*, *Barbados*, *Matinino*, *Dominica*, *Deſrada*; *Guadalupe*, *Antego*, S. *Chriſtopher*, *Nieves*, *Sancta Crux*, and ſome leſſer Iſles belonging to them: As alſo *Portorico*, *Monico Hiſpaniola*, *Cuba* and *Jamaica*. Thus I have finiſhed the Deſcription of the known Earth.

Now the Names of the Seas are theſe: *Viz.* the *Ocean Sea*, *Narrow Sea*, *Mediterranean Sea*, *Mare Major*, *Mare Pacificum*, *Mare Caſpium*, the *Eaſt-Indian Sea*, *Perſian Sea*, *Red Sea*, and *Mare-del-Zuz*, which are all the Principal Seas.

Thus through the Bleſſing of God I have given you a brief, tho' true Deſcription of all the known *Earth* and *Seas*, and have thus finiſhed my *Geographical Deſcriptions* of the *Diviſion* of the *Earthly Globe*.

Of

§. 2.

The Author on the Difficulties in the Collection of his ΜΙΚΡΟΚΟΣΜΟ'Σ, *or little Deſcription of the great World.*

Oh thou Urania! *Thou that haſt now brought*
Our Ship *to* Harbour *ſound, and richly fraught.*
Tho' Æolus his bluſtring Gales did ſend,
And foaming Billows high, the Skies did rend:
Tho' Bluſtring ſtorms, and Thunder loud did roar,
And darkneſs Grim, oppreſt our Souls all 'ore;
So that we could not view the Stars, *nor* Sky,
Nor Sun, *nor* Moon, *nay* Earth, *could not eſpy.*
Yet by thy Art, ſuch ſafety we did find,
Safely to paſs both raging Seas, and Wind.
And at the laſt a Harbour, ſafe did gain:
Rejecting fears; we quite caſt off our pain.
When Seas are calm, and Winds more ſerene be,
Then we again will put our Ship to Sea;
That when refreſht we farther may deſcry,
And ſearch into this Noble Treaſury.

Δόξα Θεῷ.

---

§. 3.

SECT. III.

Of Geographical Propoſitions.

PROP. I.

How to find the Diſtance of any two Cities or Places, which differ onely in Latitude.

IN this Propoſition there are two Varieties which are theſe.

1. If both the Places lie under one and the ſame *Meridian*, and on one and the ſame ſide the *Equinoctial*, either on the *North* or *South* ſide thereof; then ſubſtract the leſſer *Latitude* from the greater, and convert their difference into *Miles* (by allowing 60 *Miles* for a *Degree*) ſo have you the diſtance of the two Places propounded.

2. But if the two Places lie under one and the ſame *Meridian*, but the one on the South ſide of the *Equinoctial*, and the other on the North ſide, then add both their *Latitudes* together their Sum is their Diſtance.

PROP. II.

To find the Diſtance of any two Places which differ only in Longitude.

There are alſo in this Propoſition two Varieties.

1. The two Places may both lie under the *Equinoctial*, and ſo have no *Latitude*: and if ſo, ſubſtract

ſubſtract the leſſer *Longitude* out of the greater, and convert the remainder into *Miles*; ſo have you the diſtance of any two Places ſo poſuited. §. 3.

2. But if the two Places differ only in *Longitude*, and lieth not under the *Equinoctial*, but under ſome other *Intermediate Parallel of Latitude*, between the *Equinoctial*, and one of the *Poles*: Then to find their diſtance, this is the *Analogy* or *Proportion*.

As Radius or S. 90°,
To Sc. *of the Latitude*:
So is S. *of* ½ X. *of Longitude*,
To S. of ½ *their diſtance*, which being doubled, and converted into Miles, giveth the required diſtance.

PROP. III

To find the Diſtance of any two Places, which differ both in Latitude, and in Longitude.

In this Propoſition three Varieties do preſent themſelves to our View.

1. One of the Places may lie under the *Equinoctial* and have no *Latitude*, and the other under ſome *Parallel of Latitude* between the *Equinoctial* and one of the *Poles*. In ſuch caſe obſerve this *Analogy* or *Proportion*.

As Radius or S. *of* 90°,
To Sc. *of their* X. *of Longitude*:
So is Sc. *of their Latitude*,
To Sc. *of their Diſtance required.*

§. 3. 2. But if both the Places propoſed ſhall be without the *Equinoctial*, but on the one ſide either both towards the *North*, or both towards the *South*, then their Diſtance may be found, by this *Analogy* or *Proportion*.

As Radius or S. 90° 00′,
To Sc. *of their* X. *of Longitude:*
So is Tc. *of the greater Latitude,*
To the T. *of a fourth Arch*, which ſubſtracted from the *Complement* of the leſſer *Latitude*, the remainder muſt be the *fifth Arch*; Then ſay,

As Sc. *of the fourth Arch,*
To Sc. *of the fifth Arch:*
So is S. *of the greater Latitudes,*
To Sc. *of the Diſtance of the two propoſed Places.*

3. The two Places propounded may be ſo ſituated, that one of them may lie on the *North*, and the other on the *South* ſide the *Equinoctial*: the Diſtance of Places ſo ſituated may be obtained, by this *Analogy* or *Proportion*.

As Radius or S. 90°,
To Sc. *of* X. *of Longitude:*
So is Tc. *of the greater Latitude,*
To T. *of a fourth Arch*, which being ſubſtracted out of the Summ of the other *Latitude*, and the *Radius* or 90° *Deg.* the remainder is a *fifth Arch*; Then ſay,

As Sc. *of the fourth Arch,*
To Sc. *of the fifth Arch:*
So is S. *of the Latitude firſt taken,*
To Sc. *of the Diſtance required.*

Theſe are all the Varieties of the Poſitions of Places on the *Terreſtrial Globe*: For if the Diſtance of any two Places be required, they muſt fall under one or other of theſe Varieties, and may be obtained by one or other of the *Proportions*, mentioned in the three aforegoing Propoſitions. §. 3.

Alſo if you know the *Latitude* and *Longitude* of any two fixed *Stars*, or their *Right Aſcenſion* and *Declination*, then by theſe Rules their Diſtance may be found, which is of good uſe to *Aſtronomy*. It may alſo be applyed to *Circular Sailing*; of all other ways the moſt perfect: which is treated of in its due Place.

CHAP.

CHAP. VIII.

Of NAVIGATION.

NAVIGATION *So called from* Navis *a Ship, is an Art Mathematical, which ſheweth how by the ſhorteſt good Way, by the apteſt Direction, and in the ſhorteſt Time, to conduct a Ship from any one place unto any other place aſſigned: it hath been highly eſteemed by the Ancients; it is the Glory, Beauty, Bullwark, Wall and Wealth of* Britain, *and the Bridge that joyns it to the Univerſe. Navigation is commonly divided into three ſorts of Sailing:* viz. *Plain ſailing, Mercator's ſailing, and Circular ſailing: Of all which three Parts I ſhall treat in their Order.*

SECT.

SECT. I. §. 1.

Of Plain ſailing, or ſailing by the Plain Chart.

Plain Sailing, or ſailing by the *Plain Chart*, is the moſt plaineſt way, and the Foundation of all the Reſt: and although the Ground and Projection of the *Plain Chart* is erroneous, yet ſeeing it is more facile to the Learner, and may ſerve indifferently near the *Equinoctial*, becauſe there the *Degrees* of *Longitude*, as well as the *Degrees* of *Latitude*, are Equal: Each Degree being divided into 60 *Minutes*, or *Milles*, though they are ſomewhat more than *Engliſh Miles*, Each *Minute* or *Mile* containing about 6000 Feet.

PROP. I.

The Doctrine of Right-lined Triangles, both Right, and Oblique-Angled, applied to Propoſitions of Plain Sailing.

The Rumb, and Diſtance ſailed thereon being given, to find the Difference of Latitude, and the Departure from the Meridian.

Admit a Ship ſails N. W. by N. 372′ or Miles, or 124 Leagues, I demand her *Difference of Latitude* and departure from the *Meridian*?

In

CHAP. VIII.

Of NAVIGATION.

NAVIGATION *So called from* Navis *a Ship, is an Art Mathematical, which ſheweth how by the ſhorteſt good Way, by the apteſt Direction, and in the ſhorteſt Time, to conduct a Ship from any one place unto any other place aſſigned: it hath been highly eſteemed by the Ancients; it is the Glory, Beauty, Bulwark, Wall and Wealth of* Britain, *and the Bridge that joyns it to the Univerſe. Navigation is commonly divided into three ſorts of Sailing:* viz. *Plain ſailing, Mercator's ſailing, and Circular ſailing: Of all which three Parts I ſhall treat in their Order.*

SECT.

SECT. I. §. 1.

Of Plain ſailing, or ſailing by the Plain Chart.

Plain Sailing, or ſailing by the *Plain Chart*, is the moſt plaineſt way, and the Foundation of all the Reſt: and although the Ground and Projection of the *Plain Chart* is erroneous, yet ſeeing it is more facile to the Learner, and may ſerve indifferently near the *Equinoctial*, becauſe there the *Degrees* of *Longitude*, as well as the *Degrees* of *Latitude*, are Equal: Each Degree being divided into 60 *Minutes*, or *Milles*, though they are ſomewhat more than *Engliſh Miles*, Each *Minute* or *Mile* containing about 6000 Feet.

PROP. I.

The Doctrine of Right-lined Triangles, both Right and Oblique-Angled, applied to Propoſitions of Plain Sailing.

The Rumb, and Diſtance ſailed thereon being given, to find the Difference of Latitude, and the Departure from the Meridian.

Admit a Ship ſails N. W. by N. 372′ or Miles, or 124 Leagues, I demand her *Difference* of *Latitude* and departure from the *Meridian*?

In

§. 1. In the *Triangle* ABC, the *Hypothenuse* AC
Fig. 44. represenſteth the diſtance ſailed, or *Rumb-line*, BC the departure from the *Meridian*, and AB the difference of *Latitude*.

1. To find which ſay,
As Radius or S. 90°,
To Log. diſtance ſailed 372′.
So is Sc. *V.* A of the Courſe 56° 15′.
To Log. cr. AB 309$\frac{3}{10}$ Minutes, which being divided by 60′ giveth 5°. 9′. 18″ for the *Difference of Latitude.*

Fig. 44. 2. To find the Departure from the *Meridian* ſay,
As Radius or S. 90°,
To Log. Rumb-line AC 378′.
So is S. of *V.* of the Courſe A 33° 45′,
To Log. cr. BC 206$\frac{6}{10}$ Minutes, the departure from the *Meridian*, which divided by 60 giveth 3°. 26′. 36″ for the difference of *Longitude.*

Note that by this Propoſition you may keep an Account how much you have ſailed either *Eaſt* or *Weſt*, *North* or *South.*

PROP. II.

By the Rumb and Difference of Latitude given, To find the Diſtance, and the Departure from the Meridian.

Fig. 44. Admit a Ship ſail N. W. by W. untill her difference of *Latitude* be 309$\frac{3}{10}$ Minutes, I demand her diſtance ſailed, and her departure from the *Meridian?*

1. To

1. To find the distance, say, §. 1.
As Sc. of *V.* of the Course A 56° 15′,
To Log. cr. AB the X. of Lat. 309⅜ Minutes.
So is the Radius or S. 90°,
To Log. AC 372 the distance sailed.

2. For the *Departure*, say, Fig. 44.
As Sc. of A 56° of the Course 56° 15′,
To Log. cr. AB X. of *Lat.* 309⅜ Minutes,
So is S. of *V.* of the Course A 33° 45′,
To Log. cr. AB 206⅝ Minutes, the *Departure* required.

☞ By the help of this Proposition, when your *Latitude* by Observation doth not agree with your dead reckoning, (kept by the former Proposition) Then according to this Rule, you may make your way sail agree with your *Observed Latitude*, and so correct your Account or dead Reckoning.

PROP. III.

By knowing the Distance of the Meridians of two Places, and their Difference of Latitude, to find the Rumb, and Distance.

Admit A, to represent the *Lizard*, AB the *Parallel* thereof, C. St. *Mary's Islands*, being one of the *Azores*, and CB the *Meridian* thereof.

In the *Triangle* ABC, there is given the side AB 816 Minutes, the Distance of the *Lizard*, from the *Meridian* of St. *Marys*, and the side CB their difference of Latitude 768 Minutes, I demand the *Rumb*: i. e. the Angle at C, and the Distance of the *Lizard* from St. *Marys*? Fig. 45.

1. For

Fig. 1. 1. For the *Rumb* or Angle at C, say,

As Log. cr. CB 368',
To Radius or S. 90°,
So is Log. cr. AB 816',
To T. *of the Rumb*, or Angle at C 46° 44';

and is from the *Lizard* unto St. *Marys* to the fourth *Rumb* of the *Meridian*, and 1° 44' more, *Viz.* S. W. and 1° 44' Westerly, or from St. *Marys*, to the *Lizard*, N. E. and 1° 44' Easterly: and thus it shall be by the *Plain Chart*.

2. For their *Distance* AC, say,

As S. *Rumb* or *V.* at C. 46° 44',
To Log. cr. AB 816' Minutes.
So is Radius or S. 90°,
To Log. Hypoth. is C 1120', which is the Distance of the *Lizard*, unto St. *Marys Island*, and such should be the distance by the *Plain Chart*.

PROP. IV.

Admit two Ships to set sail from one Port, one Ship sails W. S. W. 40', the other W. by N. so far untill she finds the first Ship to bear from her S. E. by E. I demand the second Ships distance from the Port, and their Distance asunder?

Fig. 46. In the *Triangle* ADE, let A represent the *Port*, AD the W. S. W. course, and AE the Course W. by *North*.

1. To find the second Ships distance from the *Port*, say,

As S. of *V.* at E. 22° 30',
To Log. cr. AD 40' Minutes.

So

So is S. of *V.* at D 123° 45′, §. 1.
To Log. cr. AE 86,$\frac{88}{100}$ Minutes, which is the distance required. *Fig.* 46.

2. To find the two Ships their distance Asunder, say,

As S. of *V.* at E 22° 30′,
To Log. cr. AD 40 Minutes.
So is S. of *V.* at A 33° 45′,
To Log. cr. DE 58,$\frac{12}{100}$ Minutes, which is the Distance required.

PROP. V.

Two Ships sets sail from two Ports, which lie N. and South of each other, the one sails from the Northermost Port 72,$\frac{22}{100}$′, *and then meets the other Ship, which came from the Southermost Port, on a N. W. Course, and had sailed from thence* 56,$\frac{80}{100}$′ *I demand the Rumb on which the first ship made her way, and also the Distance between the two Ports?*

In the *Triangle* ADE, let A be the Southermost Port, AD the Course and way of the second Ship N. W. 56,$\frac{80}{100}$′, let E be the Northermost Port, ED the Course and Way of the other Ship 72,$\frac{22}{100}$′, and D the Place where they both meet. *Fig.* 47.

1. To find the *Rumb* on which the first Ship sailed, say,

As Log. cr. DE 72,$\frac{22}{100}$ Minutes,
To S. of *V.* at A 45° 00′.
So is Log. cr. DA 56,$\frac{80}{100}$ Minutes,

To

§. 1. *To* S. of *V.* at E. 33° 45′, which shewth the Course of the first Ship to be S. W. by South.

Fig. 47. 2. To find the Distance between the two Ports A and B, say,

As S. of *V.* at A 45° 00′,
To Log. cr. DE 72 Minutes,
So is S. of *V.* at D 101° 15′,
To Log. cr. EA 100′, which is the required Distance.

PROP. VI.

Admit a Ship coming off the Main Ocean and I had Sight of a Promontory or Cape, by which it is my desire to sail, I find it to bear from me S. S. E. and distant by Estimation 33′ or Miles; But keeping still on my Course S. until the Evening, having sailed 36′ or Miles, I would then know how the Cape bears, and its distance from the Ship?

In the *Triangle* ADE, admit that at A, I do observe the *Cape* D, to bear from me S. S. E. 33′ and having sail'd from A, to E 36′ South, I desire to know its Distance, and bearing. In
Fig. 48. the *Triangle*, there is therefore given, AD 33′, AE 36′, and the Angle at A 22° 30′.

1. To find the Angle at E, say,
As Z. cr. AE, and AD 69′,
To X. cr. AD, and AE 03′.
So is T. ½ *VV* unknown D and E 78° 45′,
To the T. of 12° 20′, which taken from 78° 45′, leaves the Angle at E 66° 25′, so that the

Cape

Cape D then bears from me E. N. E. and 01° 05′ Northerly. §. 1.

2. To find the Distance of the *Cape* ED from the Ship, say,

As S.V. at E 66° 25′,
To Log. cr. AD 33′.
So is S.V. at A 22° 30′,
To Log. cr. ED $13\frac{78}{100}$ Miles distant, so that the *Cape* is then distant from the Ship $13\frac{78}{100}$ Miles.

PROP. VII.

Two Ports both lying in one Latitude, distant 64′ or Miles, the Westermost of those Ports lieth opposite to an Island, more Northerly distant therefrom 47′ or Miles, which Island is also distant from the Eastermost Port, 34′ or Miles, I demand the Course from the Westermost Port to that Island?

In the *Triangle* ADE, let A be the *Westermost Port*, and E, the *Eastermost Port*, distant Asunder 64′; and let D be the *Island*, distant from A 47′, and from E 34′: Then is the Angle at A required, which is the *Course* or *Rumb*, from the *Westermost Port*, unto the *Island*: To find which, say, Fig. 49.

As Log. cr. AE 64′,
To Log. Z. cr^{s}. AD, and ED 81′.
So is Log. X. cr^{s}. AD, and ED 13′,
To Log. of a certain line AO $16\frac{454}{1000}$.
Which added to AE 64, is $80\frac{454}{1000}$,
The $\frac{1}{2}$ *whereof* is AB, $40\frac{227}{1000}$
Then again say,
As Log. cr. AD 47′,

To Radius or S. 90°.
So is Log. AB 40 $\frac{227}{1000}$,
To Sc. V. at A, 58° 31′, that is N. E. by E. 2° 36′ Easterly, which is the Course from the *Westermost Port* A, unto the *Island* D.

§. 2.

SECT. II.

Of sailing by the true Sea Chart, commonly called MERCATOR'S *Chart.*

THE *true Sea Chart*, commonly called *MERCATOR'S Chart* *, performs the same Conclusions as the *Plain Chart*, and almost as speedily, but far more exactly: Because all Places may be laid down hereon, with the same truth as on the *Globe* itself: both to their *Latitudes*, *Longitudes*, *Bearing* and *Distance* from each other.

* *But is indeed the Invention of our Learned Countryman* Mr. Edw. Wright, *although this Stranger hath almost got the Name and Praise thereof.*

And here it will be necessary to have a Table of *Meridional Ports*, which I have extracted out of Mr. *Wright's Tables*, to every tenth Minute of Latitude; accounting it in single Miles, or Minutes of the *Equinoctial*, and have hereunto annexed the said Table.

A Table

§. 2.

A Table of Meridional Miles

The Deg. of Lat.	The Minutes of each Degree.						The Difference.
	0	10	20	30	40	50	
	The Meridional Miles.						
0	0	10	20	30	40	50	10
1	60	70	80	90	100	110	10
2	120	130	140	150	160	170	10
3	180	190	200	210	220	230	10
4	240	250	260	270	280	290	10
5	300	310	320	330	340	350	10
6	360	370	380	390	400	410	10
7	421	431	441	451	461	471	10
8	481	491	501	511	521	532	10
9	542	552	562	572	582	592	10
10	603	613	623	633	643	653	10
11	664	674	684	694	704	715	10
12	725	735	745	755	766	776	10
13	786	797	807	817	827	838	10
14	848	858	869	879	889	900	10
15	910	920	931	941	951	962	10
16	972	983	993	1004	1014	1024	10
17	1035	1045	1056	1066	1077	1087	10
18	1098	1108	1119	1129	1140	1150	10
19	1161	1172	1182	1193	1203	1214	10
20	1225	1235	1246	1257	1267	1278	11
21	1289	1299	1310	1321	1332	1342	11
22	1353	1364	1375	1386	1396	1407	11
23	1418	1429	1440	1451	1462	1473	11
24	1484	1499	1505	1516	1527	1538	11
25	1549	1561	1572	1583	1594	1605	11
26	1616	1627	1638	1649	1661	1672	11
27	1683	1694	1705	1717	1728	1738	11
28	1751	1761	1773	1785	1796	1808	11
29	1819	1830	1842	1853	1865	1867	11

§. 2.

A Table of Meridional Miles.

The Deg. of Lat.	*The Minutes of each Degree*						The Difference
	0	10	20	30	40	50	
	The Meridional Miles.						
30	1888	1899	1911	1923	1934	1946	12
31	1958	1969	1981	1993	2004	2016	12
32	2028	2040	2052	2063	2075	2087	12
33	2099	2111	2123	2135	2147	2159	12
34	2171	2183	2195	2207	2219	2231	12
35	2244	2256	2268	2281	2293	2305	12
36	2318	2330	2342	2355	2367	2380	12
37	2392	2405	2417	2430	2442	2455	12
38	2468	2481	2493	2506	2519	2532	13
39	2544	2557	2570	2583	2596	2609	13
40	2622	2635	2648	2662	2675	2688	13
41	2701	2714	2728	2741	2754	2768	13
42	2781	2795	2808	2822	2835	2849	13
43	2863	2876	2890	2904	2918	2931	14
44	2945	2959	2973	2987	3001	3015	14
45	3030	3044	3058	3072	3086	3101	14
46	3115	3130	3144	3159	3173	3188	14
47	3202	3217	3232	3247	3261	3276	15
48	3291	3306	3321	3336	3351	3366	15
49	3382	3397	3412	3428	3443	3459	15
50	3474	3490	3505	3521	3537	3553	16
51	3568	3584	3600	3616	3632	3649	16
52	3665	3681	3697	3714	3730	3747	16
53	3763	3780	3797	3814	3830	3847	17
54	3864	3881	3899	3616	3933	3950	17
55	3968	3985	4003	4020	4038	4056	18
56	4074	4092	4110	4128	4146	4164	19
57	4182	4201	4219	4238	4257	4275	19
58	4294	4313	4331	4351	4370	4390	20
59	4409	4428	4448	4468	4487	4507	20

§. 2.

A Table of Meridional Miles.

The Deg. of Lat.	*The Minutes of each Degree.*						The Difference.
	0	10	20	30	40	50	
	The Meridional Miles.						
60	4527	4547	4567	4588	4608	4629	20
61	4643	4670	4691	4711	4733	4754	21
62	4775	4796	4818	4839	4861	4883	22
63	4905	4927	4949	4972	4994	5017	23
64	5039	5062	5085	5018	5132	5155	23
65	5179	5203	5226	5250	5275	5299	24
66	5324	5348	5373	5390	5423	5449	25
67	5474	5500	5520	5552	5678	5704	26
68	5631	5658	5685	5712	5739	5767	27
69	5795	5823	6021	5879	5908	5937	28
70	5966	5996	6125	6055	6085	6115	30
71	6146	6177	6208	6239	6271	6303	31
72	6335	6368	6401	6431	6468	6501	33
73	6535	6570	6605	6640	6675	6718	35
74	6747	6783	6820	6857	6895	6933	37
75	6972	7010	7050	7089	7130	7170	40
76	7211	7253	7295	7338	7381	7424	43
77	7469	7513	7559	7605	7651	7698	46
78	7746	7795	7844	7894	7944	7996	50
79	8048	8100	8154	8209	8264	8320	55
80	8377	8435	8495	8555	8616	8678	60
81	8742	8806	8872	8939	9007	9077	68
82	9148	9221	9295	9371	9449	9528	77
83	9609	9692	9778	9865	9954	10046	88
84	10141	10238	10333	10441	10547	10656	105
85	10770	10887	11007	11133	11263	11396	128
86	11539	11686	11839	11999	12168	12344	165
87	12521	12718	12921	13150	13388	13621	230
88	13920	14221	14550	14914	15321	15783	386
89	16318	16950	17726	18729	20152	22623	

§. 2. *The Use of the Table is demonstrated by the several Examples following, after this Manner.*

PROP. I.

To find by the Table, what Meridional parts are contained in any Difference of Latitude.

In this Proposition three Varieties present themselves unto our View.

1. When one Place is under the *Equinoctial*, the other having *North*, or *South Latitude*, his *Meridional parts* corresponding, is to be esteemed for the *Meridional Difference* of *Latitude*.

2. When both Places are towards one of the *Poles*, then the *Meridional parts* of the *lesser*, taken from the *Meridional parts* of the *greater Latitude*, the remainder is the *Meridional difference* required.

3. When one Place hath *North*, and the other *South Latitude*, their corresponding *Meridional parts* added together gives the *Meridional difference* of *Latitude* sought: thus having found them out they may thus be applyed.

PROP.

§. 2.

PROP. II.

By knowing the Latitudes, and the difference of Longitude of any two Places, to find the Rumb, and Distance.

Admit there be a *Port* in the *Latitude* of 50° 00′ *North*, and another in the *Latitude* of 13° 12′ North, and their *Difference* of *Longitude* is 52° 57′ West, I demand the *Rumb* and *Distance?*

In the *Triangle* A b c, let A b represent the proper difference of *Latitude*, b c the *Departure*, A c the distance sailed, A the Angle of the *Course*, c the *Complement* of the *Course*. *Fig.* 50.

In the *Triangle* ABC, AB is the *Meridional difference* of *Latitude*, BC the *Difference* of *Longitude*, A the Angle of the *Rumb*, C the *Compl.* of the Angle of the *Rumb*: These things being understood the work evidently appears to be the same as in *Rightangled Plain Triangles.*

There is then required first the *Difference* of *Latitude*, and this falls under the second Variety.

One Port lieth in the Lat.	50°	00′	N. 3475	M. Parts
The other lieth in	13	12	N. 0799	
The Merid. diff. of Latit.			2676	

1. To find the *Rumb* or *Course* say,
As Merid. X. *Lat.* 2676′,
To Radius or S. 90°.

§. 2. *So is* X. *of Longitude* 3177′,
To T. *of the Rumb* 49° 53′, the *Course* therefore is S. W. $\frac{1}{2}$ W, *&c.*

Fig. 50. 2. To find the *Distance*,

Lat.	50°	00′	
Lat.	13	12	
Proper. diff. of Lat.	36	48	*which is* 2208′.

As Sc. *Course* 40° 07′,
To proper X. *of Lat.* 2208′.
So is Radius or S. 90°,
To the Distance 3426 *Minutes* as required.

PROP. III.

By knowing the Latitudes, and distance of two Places, to find the Rumb, and Difference of Longitude.

1. To find the *Rumb* or *Course* say,
As the Distance sailed,
To Radius or S. 90°.
So is the X. *of Latitude,*
To Sc. *of the Rumb* required.

2. To find the *Difference of Longitude* say,
As Radius or S. 90°,
To the X. *of Latitude in Merid. Parts.*
So is T. *of the Rumb,*
To the X. *of Longitude* required.

PROP.

§. 2.

PROP. IV.

By knowing the Latitudes, and Rumb of two Places, to find their Diſtance, and Difference of Longitude.

1. To find the *Diſtance* ſay,
As Sc *of the Rumb,*
To the X *of Latitude.*
So is Radius or S. 90°,
To the Diſtance required.

2. To find the *Difference of Longitude* ſay,
As Radius or S. 90°,
To the X. *of Latitude in M. Parts.*
So is T. of the Rumb,
To the X. *of Longitude* required.

PROP. V.

By knowing the Rumb, Difference of Longitude, and one Latitude, to find the other Latitude, and the Diſtance.

1. To find the other *Latitude* ſay,
As T. *of the Rumb,*
To the X *of Longitude in parts.*
So is Radius or S. 90°,
To the Merid. X. *of Latitude* required.

2. To find the *Diſtance* ſay,
As Sc. *of the Rumb,*
To the X. *of Latitude.*
So is Radius or S. 90°,
To the required Diſtance.

PROP.

§. 2.

PROP. VI.

By knowing the Distance, one Latitude, and Rumb, to find the other Latitude, and Difference of Longitude.

1. To find the *Difference* of *Latitude* say,
As Radius or S. 90°,
To the Distance.
So is Sc. *of the Rumb,*
To the X. *of Latitude* required.

2. To find the *Difference* of *Longitude* say,
As Radius or S. 90°,
To the Merid. X. *of Latitude.*
So is T. *of the Rumb,*
To the X. *of the Longitude* required.

SECT. III.

Of Circular Sailing, or Sailing by the Arch of a Great Circle.

§. 3.

THIS is of all other the most exact way of sailing, and above all other most perfect, shewing the neareſt way, and distance between any two *Places:* and although it is hardly possible to keep close unto the *Arch* of a *great Circle,* yet it is of great advantage to keep conveniently near it, especially in an *East* or *West Course:*

Course: In the former Propoſitions of ſailing, we uſed *Meridians*, *Parallels* and *Rumbs*, as the *Sides* of every *Triangle*, whether by the *Plain* or *Mercator's Chart*: but in *Circular ſailing* the *Rumbs* are not uſed ſo, becauſe they are *Heliſpherical-lines*, and not *Circles*; nor the *Parallels*, becauſe they are not *great Circles*: Whereas the ſides comprehending every *Spherical Triangle* are *Arches* of *great Circles*: Therefore here we uſe *Arches* of the *Meridians*, of the *Equinoctial*, and of other *great Circles* deſcribed, or ſo imagined to be deſcribed, from one Place unto another, on the *Spherical Superficies* of the *Earth* and *Sea*. §. 3.

Therefore here ariſeth two things obſervable: and,

1. If the two places lie under the *Equinoctial*, then is their Poſition *Eaſt* and *Weſt*, and their diſtance is their *Difference* of *Longitude*, converted into *Miles*: or,

2. If the two Places propoſed be in one and the ſame *Meridian*, then is their *Poſition North* and *South*, and their *Diſtance* is their *Difference* of *Latitude* converted into *Miles*.

And thus far doth *Circular ſailing* agree with the former; their difference will evidently appear by theſe following Propoſitions.

PROP.

§. 3.

PROP. I.

Two Places, the one under the Equinoctial, the other in any Latitude given; alſo their difference of Longitude given, to find.

1. *Their Diſtance in the Arch of a great Circle.*
2. *The direct Poſition of the firſt place from the ſecond.*
3. *And of the ſecond Place from the firſt.*

Here we call the *Angles* which the *Arch* makes with the *Meridians* of the places propounded, the *Angles* of the *Direct Poſitions* of thoſe places one from the other: becauſe the *Arch* of a great *Circle*, drawn between two places is the neareſt diſtance; and the moſt direct way of the one, to the other Place. Now I ſhall not here demonſtrate it by *Schemes*, as I have done in the other two Sections, but ſhall only lay down the proportions, whereby the required parts may be found; and ſo leave the ingenious Seamen to practice it with *Schemes* at his leaſure: and,

1. To find the neareſt diſtance from Place to place, in the *Arch* of a *Great Circle*: Say according to *the* 10 *Caſe* of *Rectangled Spherical Triangles*.

As the Radius,
To Sc. of X. of *Longitude.*
So is Sc. of X. of *Latitude*;
To Sc. of the *Diſtance* in the *Arch* required.

2. For the *Direct Poſition*, ſay by the 11 *Caſe* thus,

As the Radius,
To S. of X. of *Latitude.* *So*

So is Tc. of X. of *Longitude*, §. 3.
To Tc. of *V.* of *Position* required.

3. For the *Direct Position* of the second Place from the first, say by the 11 *Case* thus,
As the Radius,
To S. of the X of *Longitude*.
So is Tc. of X. of *Latitude*,
To Tc. of *V.* of *Position* required.

PROP. II.

Two Places proposed, the one lying under the Equinoctial, the other in any Latitude given; with their distance in a great Circle of the same Places being also known, to find.

1. *Their Difference of Longitude.*
2. *The direct Position from the first to the second Place.*
3. *And from the second to the first Place.*

1. For their *Difference* of *Longitude*, say by *Case* 12,
As Sc. of the *Latitude*,
To Radius.
So is Sc. of their *Distance* in the *Arch*,
To Sc. of their *Difference* of *Longitude* required.

2. Now to find the *Direct Position* from the first place to the second, say by the 13 *Case*; and thirdly, for the *Direct Position* from the second place to the first, say by the 14 *Case* of *Rectangulars*.

PROP.

§. 3.

PROP. III.

Two Places lying in one Latitude given, their difference of Longitude being alſo known, to find.

1. *The neareſt diſtance of thoſe two Places.*
2. *The direct Poſition of one Place from the other.*

The Reſolution of this Propoſition depends on the 9 *Caſe* of *Oblique Spherical Triangles*: by ſuppoſing the *Oblique Triangle*, to be transfigured or converted into two *Rectangulars*, by a ſuppoſed *Perpendicular*: and then,

1. To find the neareſt diſtance in the *Arch*, ſay by the 8 *Caſe* of *Rectangulars*.
As the Radius,
To Sc. *of the Latitude.*
So is S. *of half* X. *of Longitude,*
To S. of half the required diſtance, which doubled giveth the diſtance of the two places in the *Arches*, as ſought.

2. For the *Direct Poſition*, ſay by the 9 *Caſe*.
As the Radius,
To S. *of the Latitude.*
So is T. of half X. of *Longitude,*
To Tc. of *V.* of *Poſition* required.

PROP.

§. 3.

PROP. IV.

Two Places lying both in one Latitude given, and the neareſt diſtance being alſo known, to find.

1. *Their Difference of Longitude.*
2. *The direct Poſition of the one Place from the other.*

The Reſolution of this Propoſition falls under the 11 *Caſe* of *Oblique Spherical Triangles*: for here you have the three ſides of the *Triangle* given, *viz.* the *Arch of Diſtance*, and the other two ſides (are both equal) being the *Complements* of the places *Latitude*: and here ſeeing the two ſides are equal, therefore the two Angles of *Poſition* are alſo equal: now there is required the three Angles,

1. To find their *Difference of Longitude*, add the double of the *Complement* of *Latitude* to the *Arch of Diſtance*; then from half this Sum, deduct the *Arch of Diſtance*, and then proceed in all points as you ſee in *Caſe* the 11*th*. So ſhall their *Difference of Longitude* be obtained.

2. To find their *direct Poſition*:
Firſt, to the double *Complement* of *Latitude*, add the *Arch of Diſtance*, then from half that *agragate*, deduct the *Complement of Latitude*, and then work as before, ſo ſhall the *direct Poſition* be attained.

PROP.

§. 3.

PROP. V.

Two Places proposed lying in one Latitude, and the distance of those Places in their Parallel given; to find.

1. *Their Difference of Longitude,*
2. *Their distance in the Arch of a great Circle,*
3. *The direct Position of the one from the other.*

Now you must understand, that as the *Semidiamiter* of a *Parallel*, is in proportion to the *Semidiamiter* of the *Equinoctial*: so is any number of *Miles* in that *Parallel*, to the *Minutes* of *Longitude* answering to those *Miles*: so that if we suppose the *Semidiameter* of the *Equinoctial* to be *Radius*, then the *Semidiameter* of any *Parallel* is the *Sine* of that *Parallel's* distance from the *Pole*, that is the Sc. of the *Latitude* of that *Parallel*: Therefore,

1. To find the *Diff.* of *Longitude* say,
As Sc. *of the Latitude,*
To the Radius,
So is the Distance in that Parallel,
To the Diff. of Longitude required.

2. Now the *Difference of Latitude* being obtained, the nearest distance may be found, as in the third proposition aforegoing: 3. so likewise may the *Angles of Position* also.

PROP.

§. 3.

PROP. VI.

By knowing the neareſt Diſtance of two Places, their Difference of Longitude, and one of their Latitudes; to find the Direct Poſition thereof from the other.

This Propoſition falls under the *firſt Caſe of Oblique Spherical Triangles*, and is thus reſolved: therefore,

As S. of the Diſtance of the two Places;
To S. of their X. of *Longitude.*
So is Sc. of the *Latitude* of the one Place given,
To S. of the *Direct Poſition* from the other as was ſo required.

PROP. VII.

By knowing the Latitudes of two places; and likewiſe their Difference of Longitude; to find;

1. *The diſtance in the Arch.*
2. *The direct Poſition from the firſt to the ſecond place.*
3. *The direct Poſition from the ſecond to the firſt place.*
4. *The Latitudes and Longitudes by which the Arch paſſeth.*
5. *The Courſe and Diſtance from Place to Place through thoſe Latitudes and Longitudes according to* Mercator.

I ſhall here make uſe of M. *Norwood*'s example of a Voyage from the *Summer-Iſlands*, unto the

§ 3. *Lizard:* now becauſe the work is various I have therefore illuſtrated it with a *Scheme*, and ſhall be as brief and facile as poſſible. *Therefore*,

In the *Triangle* ADE, let A be the *Summer-Iſlands*, whoſe *Latitude* is 32° 25′, AD the *Com-*
Fig. 51. *plement* thereof 57° 35′, let E repreſent the *Lizard* whoſe *Latitude* is 50° 00′, and ED the *Complement* thereof 40° 00′, and let their *Difference of Longitude*, namely the Angle ADE be 70° 00′, now D repreſenteth the *North-Pole*, and AE an Arch of a great Circle paſſing by theſe two Places: now ſee the operation.

1. By having the *Complements* of the *Latitudes* of the two Places, *viz.* AD 57° 35′, and ED 40° 00′, and their *Difference of Longitude*, namely the Angle EDA 70° 00′: you may find the neareſt diſtance EA to be 53° 24′; by *Caſe the* 9. § 5. *chap.* 5.

Fig. 51. 2. Then having found the neareſt diſtance in the *Arch* EA to be 53° 24′, (or 3204 Miles) the *Angle of Poſition* from the *Summer Iſlands* to the *Lizard*, namely the Angle DAE, may be found by *Caſe the* 1. § 5. *chap.* 5. to be 48° 48′, that is N.E. and 03° 48′ Eaſterly.

3. And alſo by the ſame *Caſe*, may the *Direct Poſition* from the *Lizard*, to the *Summer-Iſlands*, namely the Angle AED be found to be 81° 10′, that is W. by N. and 2° 25′ Weſterly.

4. In order to the finding the *Latitudes* and *Longitudes* by which the *Arch* paſſeth, firſt
Fig. 51. let fall the *Perpendicular* DB, ſo is the *Oblique Triangle* ADE converted into two *Rectangulars*, *viz.* ABD, and DBE: ſecondly, by *Caſe the* 8. § 4. *chap.* 5. you may find the length of the

Perpen-

Perpendicular DB to be 39° 26′, whose *Complement* is 50° 34′, which is the greatest *Latitude* by which the *Arch* ABE passeth, so the greatest *Obliquity* of the *Equinoctial* from that *Circle* is 50° 34′. Thirdly, by *Case the* 1. §. 4 *chap.* 5. you must find the *vertical Angles*, *viz.* ADB, and BDE, which will appear, the Angle ADB to be 58° 31′, and EDB to be 11° 29′: now these things being obtained, the *Latitudes* by which the *Arch* passeth at every tenth degree of *Longitude* from A, may be found by resolving the several *Right-Angled Triangles*, *viz.* BDc, BDf, &c. substracting 10° from ADB 58° 31′, there remains BDc 48° 31′, and so for the rest as in the Table. Now by knowing these *Angles* last found, and the *Perpendicular* BD before found to be 39° 26′, you may by *Case the* 3. §. 4. *chap.* 5. find the *Latitudes* of the several points A. c. f. g. h. i. B. and E. to be as in the subsequent Table. §. 3.

BDc	48°	31′
BDf	38	31
BDg	28	31
BDh	18	31
BDj	08	31

Fig. 51.

5. Thus having found the *Latitudes* and *Longitudes* of the *Arch*, and the other required parts aforementioned, we now come to shew how the *Course*, and the *Distance* from place to place according to *Mercator* may be found. So to find, first the *Course* and *Distance*

Latitude.		*Longitude.*	
A.	32° 25′	00	00′
c.	38 51	10	00
f.	43 34	20	00
g.	46 54	30	00
h.	49 04	40	00
i.	50 15	50	00
B.	50 34	60	00
E.	50 00	70	00

Fig. 51.

§. 3. Ac. now there is given the *Latitude* of A 32° 25′, and of c 38° 51′, and their *Difference of Longitude* is 10° 00′, now the *Proper Difference* Fig. 51. *of Latitude* is 6° 26′, or 386′, and *Meridional Difference of Latitude* is 475′. Now knowing theſe things by propoſition 2. § 2. *chap.* 8. you may find the *Courſe* from A to c, to be N. E. 51° 38′; and the *Diſtance* Ac to be 622′, and ſo thoſe Rules proſecuted will ſhew the courſe and diſtance from c to f; from f to g; from g to h, *&c.* So of the reſt, which for brevity ſake I ſhall omit, and leave the Ingenious Seaman to Calculate at his Pleaſure.

I might hereunto annex many more propoſitions of *Circular Sailing*, but becauſe of the ſmallneſs of this Treatiſe, and that thoſe Propoſitions already handled, being by the Ingenious Seaman well underſtood, will be ſufficient to enable him to perform any other Concluſion in *Circular Sailing* whatſoever, I therefore here omit, and haſten forwards unto the other parts of this *Mathematical Treaſury*.

A Ta-

§. 3.

A Table of Angles, which every Rumb maketh with the Meridian.

These on this side the W. incline towards the N. end of the Meridian	*Angles of Inclination with the Meridian.*		*These on this side the E. incline to the N. end of the Meridian.*
Rumbs.	North		Rumbs.
N. by W.	11°	15′	N. by E.
N. N. W.	22	30	N. N. E.
N. W. by N	33	45	N. E. by N.
North West	45	00	North East
N. W. by W.	56	15	N. E. by E.
W. N. W.	67	30	E. N. E.
W. by N.	78	45	E. by N.
West	90	00	East
W. by S.	78	45	E. by S.
W. S. W.	67	30	E. S. E.
S. W. by W.	56	15	S. E. by E.
South West	45	00	South East
S. W. by S.	33	45	S. E. by S.
S. S. W.	22	30	S. S. E.
S. and by W.	11	15	S. and by E.
Rumbs	South		Rumbs
These on this side the W. incline unto the S. end of the Meridian.			*These on this side the E. incline towards the S. end of the Meridian.*

Note that if you account in quarter of Points, add for one quarter 2° 48′, for one half 5° 37′, for three quarters 8° 26′, (not regarding the Seconds in Navigation.)

CHAP. IX.

Of SURVEYING.

IT hath been a cuſtom among Modern Authors, that have treated on this Subject, that before they entred on the Work it ſelf, to give the Deſcription of the Inſtruments, uſed in; and chiefly appertaining to the Art of *Surveying*: *viz.* the *Circumferentor*, the *Theodolite*, the *Plain-Table*, and the *Semicircle*: concerning the deſcriptions of which Inſtruments I ſhall not here treat, but refer you unto thoſe Authors that have largely and amply deſcribed them. I ſhall in this place onely demonſtrate the Uſe of the *Semicircle* in taking the *Plots* of *Encloſures*, *Champain-Plains*, *Woods* and *Mountains* divers ways *; and alſo in taking of *Acceſſible*, and *Inacceſſible Heights* and *Diſtances*; and alſo I ſhall ſhew the uſe of a little Inſtrument called a *Protractor*, in the delineating on Paper the *Plot* of a *Field*, &c. which Inſtrument being ſo commonly known, and ſo generally uſed makes me omit the deſcription thereof as ſuperfluous. As

* *Which Inſtrument, and the Plain Table, I eſteem as the two aptcſt Inſtruments for Surveying of Land*; i. e. *the Plain Table for ſmall Encloſures, and the Semicircle for Champain Plains, Woods, and Mountains.*

As for your *Chain*, I would have you, have it made of good round *Wyre*; to contain in length four *Poles*, or *Perch*, to be divided into an hundred equall parts called *Links*.

And here before we enter on the Work it self, it will be necessary to understand how by the *Protractor* to lay down an *Angle* of any quantity of degrees propounded, or to find the quantity of an *Angle* given.

SECT. I.

Of the use of the Protractor.

§. 1.

PROP. I.

By the Protractor, to Protract an Angle of any quantity of degrees propounded.

AN *Angle* may be laid down easily according to the directions of *Prop.* 5. §. 1. *Ch.* 4. but because this is more usefull in *Surveying*, Know that if it be required to protract an *Angle* of 50 deg. having drawn the line A B at pleasure, place the Centre of your *Protractor* on C, and moving it by your *Protracting Pinn*, untill the *Meridional line* thereof be directly on the line A B, then make a Mark by the division of 50° on the *limb* of the *Protractor* as at D, and *Fig.* 52.

CHAP. IX.

Of SURVEYING.

IT hath been a cuſtom among Modern Authors, that have treated on this Subject, that before they entred on the Work it ſelf, to give the Deſcription of the Inſtruments, uſed in; and chiefly appertaining to the Art of *Surveying: viz.* the *Circumferentor*, the *Theodolite*, the *Plain-Table*, and the *Semicircle:* concerning the deſcriptions of which Inſtruments I ſhall not here treat, but refer you unto thoſe Authors that have largely and amply deſcribed them. I ſhall in this place onely demonſtrate the Uſe of the *Semicircle* in taking the *Plots* of *Encloſures*, *Champain-Plains*, *Woods* and *Mountains* divers ways *; and alſo in taking of *Acceſſible*, and *Inacceſſible Heights* and *Diſtances*; and alſo I ſhall ſhew the uſe of a little Inſtrument called a *Protractor*, in the delineating on Paper the *Plot* of a *Field*, &c. which Inſtrument being ſo commonly known, and ſo generally uſed makes me omit the deſcription thereof as ſuperfluous. As

* *Which Inſtrument, and the Plain Table, I eſteem as the two apteſt Inſtruments for Surveying of Land*; i. e. *the Plain Table for ſmall Encloſures, and the Semicircle for Champain Plains, Woods, and Mountains.*

As for your *Chain*, I would have you, have it made of good round *Wyre*; to contain in length four *Poles*, or *Perch*, to be divided into an hundred equal parts called *Links*.

And here before we enter on the Work it ſelf, it will be neceſſary to underſtand how by the *Protractor* to lay down an *Angle* of any quantity of degrees propounded, or to find the quantity of an *Angle* given.

SECT. I.

Of the uſe of the Protractor.

§. 1.

PROP. I.

By the Protractor, to Protract an Angle of any quantity of degrees propounded.

AN *Angle* may be laid down eaſily according to the directions of *Prop.* 5. §. 1. *Ch.* 4. but becauſe this is more uſefull in *Surveying*, Know that if it be required to protract an *Angle* of 50 deg. having drawn the line A B at pleaſure, place the Centre of your *Protractor* on C, and moving it by your *Protracting Pinn*, untill the *Meridional line* thereof be directly on the line A B, then make a Mark by the diviſion of 50° on the *limb* of the *Protractor* as at D, and *Fig.* 52.

§. 1 draw the line CD, ſo ſhall the Angle DCB, be an Angle of 50 degrees.

PROP. II.

By the Protractor given, to meaſure an Angle given.

This is performed by the line of *Chords* alſo, according to prop. 6. §. 1. chap. 4. and by the *Protractor* is found thus: Suppoſe DCB were an Angle whoſe Quantity were deſired, to find
Fig. 52. which, firſt the *Center* of the *Protractor* applyed unto the Angular point C, and its *Meridional line* lying juſtly with CB; you ſhall perceive the Point D, to touch the *limb* of the *Circle* at 50 deg. Therefore I conclude the Meaſure of the Angle DCB, to be 50 degrees.

SECT.

SECT. II. §. 2.

Of the Manifold Uſe of the Semicircle, in taking the Plots of ſmall Encloſures, Plains, Woods, or Mountains divers Ways.

PROP. I.

How to take the Plot of a Field, by the Semicircle at one Station taken in any part thereof, from whence all the Angles may be ſeen, and meaſuring from the Station unto every Angle thereof.

Suppoſe ABCDEF were a Field, and 'tis required to take the Plot thereof: Having placed marks at all the Angles thereof, and made choice of your Station, which let be K; at which, place your Inſtrument, and turning it about untill the *Needle* hang over the *Meridian Line of the Chart*, there ſcrew it faſt: Then directing your ſight to A, you'l find the Degree out by the *Index* to be 40° 15′: Then meaſuring KA with your *Chain* it appears to be 5 *Chains* and 20 *Links*, which note down in your *Field-book*: and ſo do by all the reſt untill you have found all the Angles and Diſtances from your Station K, to each reſpective Angle, which finiſhed your work will ſtand thus. *Fig.* 53.

Angles.

§. 2.

Angles.	D.	M.	C.	L.
A.	40	15	5	20
B.	88	00	6	10
C.	130	00	5	50
D.	200	00	7	00
E.	250	00	5	00
F.	310	00	5	20

PROP. II.

How to delineate on Paper any Observation taken according to the Doctrine of the last Proposition.

Upon your Paper draw a Line to represent the *Meridian line* as M, H, then Placing the Center of your *Protractor* on the point K, laying the *Meridian line* of the *Protractor* on the *Meridian line* M, H, then seeing the Angle at A was 40° 15′, make a Mark against 40° 15′ of the *Protractor*, as at A, and so do with all the other Angles, as you find them in your Table: Then remove your *Protractor*, and draw the Lines KA, KB, *&c.* This done lay down on each line his respective Measure, as it appeareth in the Table. Lastly draw the Lines AB, BC, *&c.* So have you on the Paper the exact Figure of the Field.

Fig. 53.

PROP.

§. 2.

PROP. III.

How by the Semicircle to take the Plot of a Field at one Station in any Angle thereof, from whence you may view all the other Angles, by measuring from the Stationary-Angle, unto all the other Angles.

Admit A, B, C, D, E, F, G, to be a Field, whose Plot is required: Place your *Semicircle* at G, and turning it about untill the *Needle* hang over the *Meridian line of the Chart*, and there screw it fast: Then direct your sights to the several Angles, *viz.* B, C, D, *&c.* in order one after the other, and so shall eace respective Angle be found, as in the subsequent Table: Then with your *Chain*, measure from your *Stationary-Angle* G, to all the other respective *Angles*, which done you have finished, and the work standeth thus. *Fig.* 54.

Angles.	D.	M.	C.	L.
B.	40	00	5	00
C.	88	00	6	00
D.	120	15	6	40
E.	165	00	6	30
F.	193	00	3	40
A.	348	07	4	00

PROP.

§. 2.

PROP. IV.

How to delineate any Obſervation taken according to the Doctrine of the laſt Propoſition.

Upon your Paper draw a ſtreight line as M, N, then take a point therein as G, to repreſent the *Stationary-Angle*, to which point apply the *Center* of your *Protractor*, (in all reſpects as is
Fig. 54. before taught) then according to the Notes in the Table, prick off all the Angles, *viz.* B,C,*&c.* according to their due quantity, then draw all the lines, *viz.* GB, GC, GD, *&c.* and on them place their reſpective meaſure (as appeareth in your Notes) laſtly draw the lines AB, BC, CD, *&c.* So is there on the Paper the exact Figure of the Field, as was required.

PROP. V.

How by the Semicircle to take the Plot of a Field at two Stations, by meaſuring from each Station to the viſible Angles: the Field being ſo Irregular that from no one Place thereof, all the Angles can be ſeen.

Admit A, B, C, D, E, F, G, H, I, K, to be the Figure of a Field, whoſe Plot is required: having made choice of your two *Stations*, *viz.* Q, and P, and placed Marks in all the Angles: Then place your *Semicircle* at Q, and there
Fig. 55. fix it with the *Needle* hanging over the *Meridian* of the *Chart*, repreſented by R, Q, X, and direct your ſights unto all the *viſible Angles*, viz. A, B,

A, B, C, D, E, and F, and note down the Quantity of each Angle in your *Field-book*: Then meaſure with your *Chain* from your *Station* Q, to the *Angles* A, B, C, D, E, and F, and their length ſo found, note down in your *Field-book* alſo. §. 2. *Fig.* 55.

This done direct your ſight unto your ſecond *Station* P, and note down in your *Field-book* the *degree* of *Declination*, of your *ſecond-ſtation* P, from the *Meridian*. Then meaſure the *Stationary Diſtance* PQ with your *Chain*, and note it down in your *Field-book* alſo.

Then remove the Inſtrument unto P, your *ſecond-ſtation*, and there fix it with the *Needle hanging* over the *Meridian line* of the *Chart* repreſented by TPB, then direct your ſights to the ſeveral *viſible Angles* at this ſecond Station, *viz.* F, G, H, I, and K, in order one after another, and note down the Quantity of each Angle in your *Field-book*: Then with your *Chain* meaſure from your *Station* P, to theſe ſeveral Angles G, H, I, and K, (in all reſpects as at the firſt ſtation Q.) and their length ſo found note down in your *Field-book* likewiſe: So have you finiſhed your Obſervation, and your work ſtandeth thus. *Fig.* 55.

The

§. 2.

The Observation taken at the first Station Q.

Angles.	D	M	C.	L
A	50	00	6	60
B	80	00	7	65
C	140	12	12	00
D	220	07	11	10
E	270	05	12	60
F	330	00	6	00

Fig. 55.

The *Declination* of the *Station* P, from the *Meridian* R Q X, is 30° 00′, and the *Stationary distance* Q P is 9 *Chains.*

The Observation taken at the second Station P.

Angles.	D	M	C	L
F	227	11	00	00
G	297	00	12	00
H	347	16	9	90
I	60	00	6	00
K	90	00	6	26

Fig. 55.

☞ Note that the manner of taking the Plot of a large *Champain Field*, at many Stations, is almost the same with this Proposition; for he that can do the one, can also perform the other: therefore for brevity sake I here omit it as superfluous. PROP.

PROP. VI. §. 2.

How to delineate any Obſervation taken according to the Doctrine of the laſt Propoſition.

Upon your Paper draw the *Meridian-line* R Q X, then place the Center of your *Protractor* on Q, (repreſenting your firſt Station) and its *Meridional-line* lay equal to R Q X, then prick off the *Angles viſible* at your firſt *Station* Q, *viz.* A, B, C, D, E, and F, Of their due quantity, then draw Q A, Q B, *&c.* laying on them their correſponding meaſure, noted in your Field-book. Now becauſe your *ſecond Station* P, doth decline 30° 00′, from the *Meridian* R Q X, prick off 30° 00′, and draw P Q, making it 9 *Chains* as in your Field-book appeareth, ſo doth P repreſent your *ſecond Station*. Then in all reſpects as before, place your *Protractor* at P your *ſecond Station*, and draw the *Meridian* T P B *parallel* to R Q X, then prick off the ſeveral *Angles*, *viz.* F, G, H, I, and K, Of their due quantity, and then draw PF, PH, PI, *&c.* of their due length. Laſtly draw the lines AB, BC, CD, *&c.* and ſo ſhall you have on your Paper the exact Figure of the Field as required. *Fig.* 55.

PROP.

§. 2.

PROP. VII.

How by the Semicircle, to take the Plot of a Field at two Stations, which lieth remote from you, when either by oppoſition of Enemies you may not, or by ſome other Impediment you cannot come into the ſame.

Admit the Figure A, B, C, D, E, F, to be a Field into which by no means you can poſſibly enter, and yet of neceſſity the Plot thereof muſt be had, for the obtaining of which chuſe any *two Stations*, it mattereth not whether near at hand or far off, ſo that all the *Angles* may be ſeen. Let your *two Stations* be H and L, (the full length of the Field if poſſible) then place your Inſtrument at H, and fixing it as is
Fig. 56. afore ſhewed, direct your ſights to the ſeveral *Angles* of the *Field*, viz. A, B, C, *&c.* orderly one after another, obſerving their degrees as is afore taught, noting it down in your *Field-book*: then take up your Inſtrument, leaving a mark in its room at H, And meaſure with your *Chain* from H unto L, your *ſecond Station*, which note down in your *Field-book*; Then placing your Inſtrument at L, your *ſecond Station*, and as is before taught, fixing it there, make the like Obſervation to the ſeveral *Angles*, viz. A, B, C, D, *&c.* as at the *firſt Station* H, and note it down in your *Field-book* alſo, And having ſo done you have finiſhed, and your Work ſtandeth thus.

Obſerva-

§. 2.

Observations at the first Station H, are

1 Angles	D	M
A	104	00
B	88	07
C	59	00
D	48	00
E	26	00
F	21	30

The Angle from H the first Station, unto L the second Station, is 180° 00′, the *Stationary distance* HL, is 60 *Chains*.

Fig. 56.

Observations at the second Station L, are

2 Angles	D	M
A	16	00
B	39	00
C	50	09
D	74	00
E	100	00
F	29	15

PROP. VIII.

How to delineate any Observation taken according to the Doctrine of the last Proposition.

Upon your Paper draw a Line as HL, which make equal to 60 *Chains*, then placing the Center of your *Protractor* on H, your *first Station*, prick off all the Angles A, B, C, *&c.* as you find them in your Field-book, and draw HA, HB, HC, *&c.* at pleasure: then remove your *Protractor* unto your *second Station* L, placing it as before, and prick off all the Angles *Fig.* 56.

§ 2. A, B, C, D, *&c.* as you find them in your Field notes; and draw the lines LA, LB, LC, *&c.* at length untill they interſect the former
Fig. 56. lines, HA, HB, *&c.* in the Points A, B, C, *&c.* which *Points of Interſection* are the *Angles* of the *Field.* Laſtly draw AB, BC, CD, *&c.* So ſhall you have on your Paper the Figure of your Field, required.

PROP. IX.

How by the Semicircle, to take the Plot of a great Champain-Plain, Wood, or other overgrown Ground, by meaſuring round about the ſame, and making Obſervation at every Angle thereof.

Admit A, B, C, D, be the figure of a *Large overgrown Champain-Field*; whoſe Plot is required. Firſt Place your Inſtrument at A, laying the *Index* on the *Diameter*; and turn it about, untill you eſpy the *Angle* at D, and there fix it faſt: and direct your *ſights* to B, and note the *Degree* cut by your *Index*, in your *Field-book*, (as afore is taught) then remove your Inſtrument to B, and there make the like obſervation, and ſo to C, and D, noting it down in your *Field-book*, as afore. Then with your *Chain*,
Fig. 57. meaſure the Sides AB, BC, CD, and DA, whoſe length note down in your *Field book*, and ſo you have finiſhed and your work ſtandeth thus.

Angles.

§. 2.

Angles.	D	M	C	L
DAB	100	00	12	20
ABC	117	15	10	00
BCD	71	30	19	20
CDA	71	15	12	20

PROP. X.

How to delineate any Obſervation taken according unto the Doctrine of the laſt Propoſition.

Upon your Paper draw the line AB, at Pleaſure, and placing the Center of your *Protractor* on the Point A, prick off an *Angle* of 100°, and draw AD, ſetting on it, and alſo on AB, their correſponding meaſure, in your notes: Then on B, protract an Angle of 117° 15′, draw BC of its due length: Then draw the line CD, ſo have you the exact figure of the Field, on your Paper. *Fig.* 57.

PROP. XI.

How to take the Plot of any Field, by the help of the Chain only.

Admit the Figure A, B, C, D, E, to repreſent a Field whoſe Plot is required. To obtain the which, firſt meaſure the ſides CD, CB, and BD, and note their due length down in your *Field-book*, *Fig.* 58.

§. 2. *book*, and then measure the Sides CA, and BA, and then note down their Length in your *Field-book*. Then measure the sides BE, and ED, for the sides BC, and BD, were before known) which note down in your *Field-book*. So is your Field A, B, C, D, E, reduced into three *Triangles*, viz. CBD, CAB, and BED, the length of whose sides are all known, thus you have finished, and the works stands as you see.

	Sides.	*Ch.*	*Lin.*
In the Triangle CBD	CD	5	97
	CB	8	28
	BD	8	25
In the Triangle CAB	CA	4	24
	CB	8	28
	BA	6	51
In the Triangle BED	BE	5	28
	ED	5	25
	BD	8	25

Fig. 58.

PROP. XII.

How to delineate any Observation, taken according to the Doctrine of the last Proposition.

Upon your Paper, draw a streight line, as CD, make it 5 *Chains*, $\frac{97}{100}$, take CB in your *Compasses*, and strike an *Obscure Arch*; then take BD, and with that extent in D, cross the former *Arch* in B, and draw BC, and BD. Then take in your *Compasses* BE, and on B, strike an *Obscure Arch*, then take DE, and also cross the

Fig. 58.

the former *Arch* in E, and draw BE, and ED. §. 2.
Laſtly take the line CA, and on C ſtrike an *Obſcure Arch*, then take AB, and on B, inter- *Fig.* 58.
ſect the former *Arch* in A, then draw CA, and AB, ſo have you on your Paper the exact figure of the Field A, B, C, D, E, as was required.

SECT. III.

Of finding the Area or ſuperficial Content of any Field, lying in any Regular or Irregular Form: by reducing the Irregular Fields into Regular Forms. §. 3.

HAving already ſhewed how to take the Plot of any Field divers ways, by the *Semicircle* and *Chain*, and alſo by the *Protractor* how to delineate the Draught thereof on Paper, *&c.* I now come to ſhew how the *Area* or *ſuperficial Content* of a Field may be attained, *i. e.* how many *Acres*, *Roods* and *Perches* are therein contained. To which end know; *That a Statute Pole or Perch contains* 16½ *Feet*; *that* 40 *of thoſe Perches in length, and* 4 *in breadth makes an Acre.* So that an *Acre* contains 160 *Perches*, and a *Rood* 40 *Perches*; according to the Statute 33, of *Edward* the *Firſt*.

§. 3. Now the Original of the Menſuration of *Land*, and all other *Superficies*, depends on the Menſuration of certain *Geometrical Figures*; as a *Triangle*, *Square*, &c. which may be meaſured according to the directions of §. 2. *chap.* 4 of *Geometry*: It would therefore here be ſuperfluous to make a repetition of things already handled: I ſhall therefore omit it, and come to ſhew how any Field lying in any *Irregular Form*, may be meaſured by converting it into *Regular Figures*; for it ſeldom happeneth, but that the Plot of a Field, is either a *Trapezium* *, or a many-ſided *Irregular Figure*: therefore I ſhall firſt ſhew how to find the Content of a *Trapezium*. Secondly, of any many ſided *Irregular Figure*; and thirdly, how to reduce any number of *Perches* into *Acres*, &c. and on the contrary any number of *Acres*, into *Roods* and *Perches*.

* *Is a Quadrangle, whoſe ſides are not Parallel, nor equal.*

Euclides poſtulat hanc fabricam Trapezium, tanquam menſulam vocari: & ſane nominis ejus ratio Geometrica nulla eſt: P. Rami *lib.* 14 *pag.* 94.

PROP. I.

How to find the Area or ſuperficial Content of a Trapezium.

Trapeziums are *Quadrangles* of ſundry forms: yet take this as a general Rule, whereby their Content may be found. Admit it be required to find the *Area* or *ſuperficial Content* of the *Trapezium* ABCD, to find which, firſt by drawing

the

the *Diagonal* AD, you reduceth it into two *Triangles*, ABD, and ADC. Then by prop. 3. §. 1. of Chap. 4 let fall the two *Perpendiculars* on AD, from B, and C, Then by prop 3. §. 2 Ch. 4. find the *ſuperficial Content* of the two *Triangles* ABD, and ADC, which added together, is the Content of the *Trapezium*; by which Rule the Content of the *Trapezium*, A,B,C,D, is found to be 630 *Perches*. §. 3. *Fig.* 59.

PROP. II.

To find the Area *or ſuperficial Content of a many-ſided Irregular Figure.*

Admit A, B, C, D, E, F, G, to be an *Irregular many-ſided Figure*, repreſenting a Field whoſe Content is required: now in regard the Field is *Irregular*, therefore reduce it into *Triangles*, *viz.* ABC, ACG, EDG, DEG, and DFG, and then find the Content of all the ſaid *Triangles*, by prop. 3. §. 2. Chap. 4 and add their Contents together; ſo ſhall that Sum be the Content of the ſaid Figure; and ſo do for any other. *Fig.* 60.

PROP. III.

How to reduce any Number of Perches into Acres, and on the contrary, Acres into Perches.

To find how many *Acres* are contained in any Number of *Perches* given, you muſt conſider that 160 *Perches* do make a *Statute Acre*, therefore if you divide the Number of *Perches*

§. 3. propounded, by 160, the Quotient is the number of *Acres* contained therein; and if there be a remainder which exceed 40, then divide it by 40, the Quotient ſhall be *Roods*, and the remainder *Perches*.

But on the contrary, if it were required to find how many *Perches* are contained in a certain Number of *Acres* propounded. You muſt multiply the Number of *Acres*, by 160: the product ſhall be the *Perches* contained therein.

☞ *It may be here expected, that I ſhould ſhew how to reduce cuſtomary Meaſure to ſtatute Meaſure; and alſo that I ſhould treat of the Diviſion and Separation of Land. But becauſe Mr.* Rathborne, *and of late Mr.* Holwell, *hath ſufficiently explained the ſame, by many varieties, I ſhall for brevity ſake omit it, and leave you to conſult thoſe Authors.*

SECT.

SECT. IV.

Of the Uſe of the Semicircle in taking Altitudes, Diſtances, &c. §. 4.

PROP. I.

How by the Semicircle to take an Acceſſible Altitude.

ADmit AB, be the Height of a *Tower*, which is required to be known. Firſt placing your *Semicircle* at D, (with the Arch downwards and the two ſights fixed) place it *Horizontal* * and ſcrew it faſt; Then move your *Index*, till through the ſights thereof, you eſpy the top of the *Tower* at B, and obſerve what degree the lower part of the *Index* cutteth and that will be equal unto the Angle at D 50 deg Then meaſure the diſtance DA, which let be 299 Feet. Now the heighth of the Tower AB, is found, according to prop. 1. §. 2. Chap. 5. thus, *Fig.* 61.

* *Which to do is no more than thus; with a Thread and Plummet faſtened at the Center of the Semicircle, ſo that it hath liberty to play, move the Semicircle until the Thread playeth againſt* 90 *deg. then ſcrew it faſt, and it is* Horizontal.

As Sc. *V.* at A 50° 00′
To Log. cr. DA 299 Feet.
So is S. *V.* at A 50 00,
To Log. AB 356,$\frac{3}{10}$ Feet the height of the *Tower* AB required.

PROP.

§. 4.

PROP. II.

How by the Semicircle to take an Inaccessible Altitude, at two Stations.

Let AB be a *Tower* whose height is required; having placed your Instrument at E, as before direct your sights unto the Top of the *Tower* at B, and finding the *Degree* cut by the *Index*, to be 23° 43′, I say it is the Quantity of the Angle at E: Now by reason of Water, or such like Impediment, you can approach no nearer the Base of the Tower, than D, Therefore measure ED, which is found to be 512 Feet, then at D, make the like Observation, and the Angle at D, appeareth to be 50° 00′, whose *Complement* is the Angle DBA, 40° 00′, and the *Complement* of the Angle E 23° 43′, is the Angle EBA 66° 17′: Now if the lesser Angle at B, be taken out of the greater, the remainder is 26° 17′, the Angle EBD: Now first to find the side BD, of the *Trangle* EBD, say according to *prop.* 1. §. 3. *chap.* 5. thus.

Fig. 61.

As S. *of V.* EBD, 26° 17′,
To Log. cr. ED 512 Feet.
So is S. of V. at E 23° 43′,
To Log. cr. BD 465$\frac{3}{18}$ Feet required.

Now to find the Height of the *Tower* AB, say according to *prop.* 2. §. 2. *chap.* 5. thus.

As Radius or S. 90°,
To Log. cr. DB 465$\frac{3}{18}$ Feet found.
So is S. *of V.* BDA 50° 00′,
To Log. cr. BA 356$\frac{3}{18}$ Feet, which is the height of the Tower required.

Fig. 61.

☞ Note

☞ Note that in taking any manner of *Altitude* the height of your *Inſtrument* muſt be added unto the height found, and that will give you the *True Altitude* required. §. 4.

PROP. III.

How by the Semicircle to take an Inacceſſible Diſtance at two Stations.

Admit A, and B, be the two Stations, from either of which it is required to find the diſtance unto the *Church* at C; placing your Inſtrument at B, the *Index* lying on the *Diameter*, and direct your ſights unto the *Church* at C, faſten your Inſtrument, and turn your ſights about untill you ſee through your ſights, your ſecond Station at A, ſo will you find your *Index* to cut 30° 00′, which is the Quantity of the Angle ABC. Then meaſure the diſtance AB, which is found to be 250 Yards, then with your Inſtrument at A, make the like Obſervation as before, and you will find the Angle BAC to contain 50° 00′. Now by the third *Maxim* of *Plain Triangles* §. 1. *Chap.* 5 you find alſo the Angle ACB, to be 100° 00′: now to find the diſtance AC, and BC, you may by their oppoſite proportion according to *prop.* 1. §. 3. *chap.* 5. find the diſtance of AC, thus. *Fig.* 62.

As S. *of V.* at C 100° 00′,
To Log. cr. AB 250 yards.
So is S. *of V.* B 30° 00′,
To Log. cr. AC 127 yards. Which is the diſtance of the *Church* from A.

Now

§. 4. Now to find the distance BC, say,
As S. *of V.* at A 100° 00′,
To Log. cr. AB 250 yards.
So S. *is of V.* at A 50° 00′,
To Log. cr. BC 194$\frac{4}{10}$ yards, which is the distance of the *Station* B, from the *Church* at C.

PROP. IV.

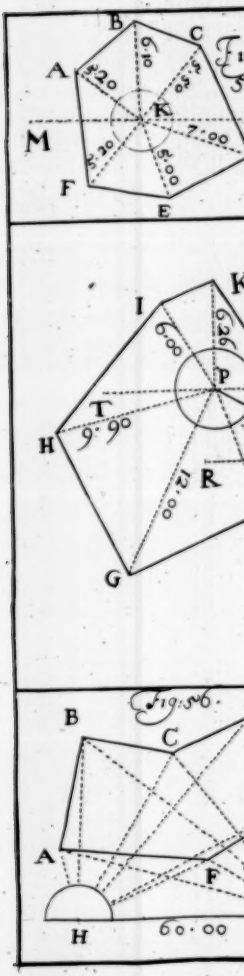
How to find the Horizontal line of any Hill or Mountain, by the Semicircle.

Let Figure 63 be a *Mountain*, whose *Horizontal-line* AB is required to be found: to find which, place your Instrument at A, and having caused a Mark to be placed on the Top of the *Mountain* at C; (of the just height of your Instrument) then move your *Index*, untill through the sights thereof you espy the Mark at C, so will you find the Quantity of the An-
Fig. 63 gle CAD, to be 50° 00′, and by consequence the Angle ACD to be 40° 00′, then measure up the *Hill* AC, which is 346 yards. Now having obtained these several things, 'tis required to find the length of AD part of AB; to find which say,
As Radius or S. 90°,
To Log. cr. AC 346 Feet.
So is Sc. *of V.* at A 50° 00′,
To Log. cr. AD 222$\frac{4}{10}$ Feet.

Now seeing the *Hill* or *Mountain* descendeth on the other side, you must place your Instrument at C, and direct your sights unto the *Bottom* at B, and the Angle DCB will be found 50° 00′, and the Angle CBD 40° 00′. Then measuring down the *Mountain* as CB, it appeareth

§.

Fig.



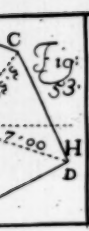


Fig: 53.

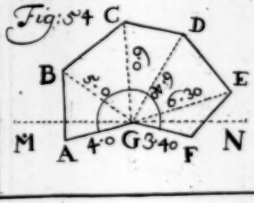


Fig: 54

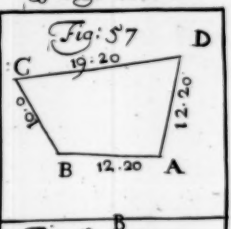


Fig: 57

4

63.

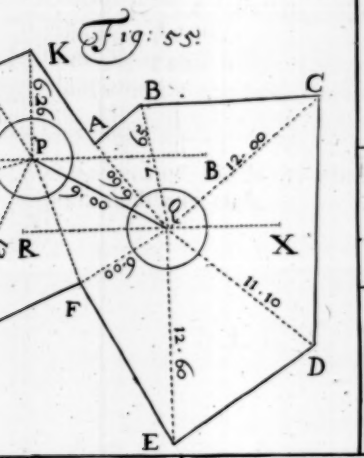


Fig: 55.

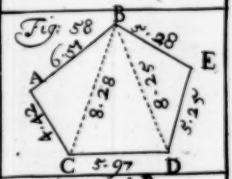


Fig: 58

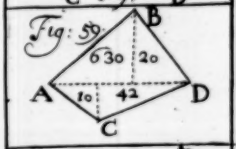


Fig: 59

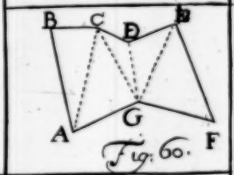
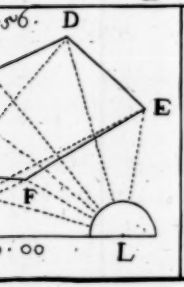


Fig: 60.



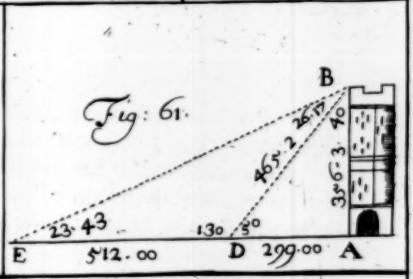


Fig: 61.

reth to be 415 Feet; then have you the Angles DCB, and CBD. §. 4.

To find DB, part of AB, ſay,

As Radius or S. 90°,

To Log. cr. CB 415 Feet.

So is S. *of V.* BCD 50° 00′,

To Log. cr. DB, 318 Feet: Now AD 222$\frac{4}{10}$ Feet added thereunto produceth AB 540$\frac{4}{10}$ Feet, which is the *Horizontal line* required of the *Mountain* ACBD. *Fig.* 63.

☞ Note that when you come to delineate a Field wherein are *Hills*, you muſt protract the line AB, inſtead of the *Hypothenuſal* Lines AC, and CB, and 'twill be neceſſary to diſtinguiſh thoſe kind of Fields, by ſhadowing them off with *Hills* and *Dales*.

SECT. V.

How to find whether Water may be conveyed from a Spring-Head unto any appointed Place. §. 5.

THE Art of conveying of *Water* from a *Spring-Head* unto any appointed Place, hath a ſpecial reſpect unto meaſuring, and therefore I think it not amiſs to aſſert it in this place, and enroll it under the Title of *Surveying*.

In

§. 5. In the performance of which we make uſe of a *Water-level*, the Conſtruction and making whereof is ſufficiently known to thoſe who make *Mathematical Inſtruments:* Now if it were required to find whether Water may be conveyed in *Pipes*, &c. to any Place aſſigned: to perform which obſerve theſe Rules.

Firſt at ſome 10, 20, 30, 40, 60, or 100 yards diſtant from the *Spring-head* in a right line towards the Place unto which your Water is to be conveyed. Place your *Water-level*, being prepared of two *Station Staves* with moveable *Vanes* on each of them, graduated alſo after the uſual Manner: Cauſe your firſt *Aſſiſtant* to ſet up one of them at the *Spring-Head*, *Perpendicular* unto the *Horizon*, and your ſecond *Aſſiſtant* to erect another, as far from your *Water-level* towards the Place to which the Water is to be conveyed, as your *Water-level* is diſtant from the *Spring-head:* Now the *Station-ſtaves* in this order erected, and your *Water-level* placed preciſely *Horizontal*, go unto the end of the *Level*, and looking through the ſights, cauſe your firſt *Aſſiſtant* to move a Leaf of Paper, up or down your *Station ſtaff*, untill through the ſights you eſpy the very edge thereof, and then by ſome known *ſign* or *ſound*, intimate to your *Aſſiſtant* that the Paper is then in its true poſition, then let the firſt *Aſſiſtant* note againſt what Number of *Feet*, *Inches*, and parts of an *Inch* the edge of the Paper reſteth; which he muſt note down in a Paper. Then your *Water-level* remaining immoveable, go to the other end thereof, and looking through the ſights towards your other *Station-ſtaff*, cauſe your

your ſecond *Aſſiſtant* to move a Leaf of Paper along the *Staff*, till you ſee the very edge thereof through the ſights, and then cauſe him by ſome known *ſign* or *ſound*, to take notice what number of *Feet*, *&c.* are cut by the ſaid *Paper*, which let him keep, as your firſt *Aſſiſtant* did. §. 5.

This done let your firſt *Aſſiſtant* bring his *Station-ſtaff* from the *Spring-head*, and cauſe your *ſecond Aſſiſtant* to take that *Staff*, and carry it forwards towards the Place, unto which the Water is to be conveyed; ſome 30, 40, 60, or 100 yards, and there to erect it *Perpendicular* as before, letting your *ſecond Aſſiſtant's ſtaff* ſtand immoveable, and your firſt *Aſſiſtant* to ſtand by it: Then in the *Midway* between your two *Aſſiſtants*, place your *Water-level* exactly *Horizontal*, and looking through the ſights thereof, cauſe your firſt *Aſſiſtant*, and after that your ſecond, to make their ſeveral obſervations in all reſpects as before.

In this manner you muſt go along from the *Spring-head*, to the place unto which you would have the Water conveyed, and if there be never ſo many ſeveral Stations, you muſt in all of them obſerve this manner of work preciſely; ſo that by comparing the notes of your two *Aſſiſtants* together, you may eaſily know whether the *Water* may be conveyed from the *Spring-head*, or not, by calling your two *Aſſiſtants* together, and cauſing them to give in their notes of obſervation at each *Station*, which add together ſeverally: Then if the Notes of the *ſecond Aſſiſtant*, exceed the Notes of the *firſt Aſſiſtant*, take the leſſer out of the greater, and the

§. 5. the remainder will ſhew you how much the appointed *Place*, to which the *Water* is to be conveyed, is lower than the *Spring-head.*

The firſt Aſſiſtant's Note.			
Station.	*Feet.*	*Inch.*	*Parts.*
1	15	3	.50
2	2	1	.25
3	1	6	.00
Sum	18	10	.75

The ſecond Aſſiſtant's Note.			
Station	*Feet.*	*Inch.*	*Parts.*
1	3	2	.75
2	14	0	.25
3	3	11	.00
Sum	21	2	.00

By theſe two Tables you may perceive that the Notes of the firſt *Aſſiſtant* collected at his ſeveral Stations, being added together, amounts unto 18 *Feet*, 10 *Inches*, and $\frac{75}{100}$ or $\frac{3}{4}$ of an *Inch*: and the Notes of your ſecond *Aſſiſtant* collected at his ſeveral Stations, amounts unto 21 *Feet*, 2 *Inches*: So that the number of the *firſt Aſſiſtant's Obſervations*, being taken from the *ſecond's*, there will remain 2 *Feet*, 3 *Inches*, and $\frac{25}{100}$ or $\frac{1}{4}$ of an *Inch*. And ſo much is the *place* unto which the *Water* is to be brought, lower than the *Spring-Head*, according to the ſleight *Water-Level*, and therefore the Water may eaſily be conveyed thither. And here obſerve theſe Notes.

☞ 1 In

☞ 1. In your Paſſage between the *Spring-head*, and the appointed *Place*, from *Station* to *Station*, you muſt obſerve this order, that your firſt *Aſſiſtant* at every *Station* muſt ſtand between the *Spring-head*, and your *Water-level*: otherwiſe great Errours will enſue. §. 5.

☞ 2. That if the Notes of your *firſt Aſſiſtant*, exceed the Notes of the *ſecond Aſſiſtant*, then 'tis impoſſible to bring the *Water* from that *Spring-head* unto the *appointed place*, but if their Notes are equal, it may be done, if the diſtance be but ſhort.

☞ 3. That the moſt approved Authors concerning this particular do aver, that at every *Mile's* end there ought to be allowed $4\frac{1}{2}$ *Inches* more than the *Streight-level*, for the current of the *Water*.

☞ 4. That if there be any *Mountains* lying in the way betwixt the *Spring-head* and the *Place* to which the *Water* is to be conveyed, you muſt then cut a *Trench* by the ſide of the *Mountain*, in which you muſt lay your *Pipes* equal with the *ſtreight Water-level*, with the former allowance: and in caſe there be a *Valley*, you muſt then make a *Trunk* of ſtrong wood, well under-propped with *ſtrong pieces* of *Timber*, well *Pitched*, or *Leaded*, as is done in divers places between *Ware* and *London*.

☞ 5. That when the *Spring* will have too violent a *Current*, you muſt then convey your *Water* to the place *aſſigned*, by a *Crooked* or *Winding line*, and you alſo ought to lay the *Pipes*, the one up, and the other down, that thereby the *Violence* of the *Current* may be ſtopped,

CHAP. X.

Of MEASURING,

Of Board, Glass, Tiling, Paving, Timber, Stone, and Irregular Solids, such as Geometry can give no Rule for the Measuring thereof.

SECT. I.

§ 1. *Of the Measuring of Board, Glass, Paving, Tiling,* &c.

I Have already in the fourth Chapter of this Book, and the second Section thereof, applyed *Geometry* to the finding out of the *Superficial Content* of all *Regular Superficies*. I have also in the ninth Chapter, and the third Section thereof, shewed how the *Superficial Content* of any *Irregular Superficies* may be found, by reducing

cing them into *Regular Forms:* which I have explained amply in that Section, I shall therefore here be as plain and brief as is possible. §. 1.

PROP. I.

To Measure a Piece of Board, Plank, Glass, &c.

In Measuring of *Board, Glass,* &c. *Carpenters* and other *Mechanicks* measure by the *Foot,* 12 *Inches* unto the *Foot*; so that a *Foot* of *Board,* or *Glass,* contains 144 *Square Inches.*

Now if a Piece of *Board, Plank,* or *Glass,* be required to be measured, let it be either a *Parallelogram,* or *Tapering Piece:* first by the Rules aforegoing find the Content thereof in Inches, and that Product divide by 144, the Quotient is the Content of that *Superficies* in *Feet.*

PROP. II.

To measure Tiling, Flooring, Roofing, and Partitioning-works.

In *Tiling, Flooring, Roofing,* and *Partitioning-work, Carpenters,* and other *Workmen,* reckon by the *Square,* which is 10 Feet every way; so that a *Square* containeth 100 *Feet:* Example.

There is a *Roof* 14 *Feet* broad, what length thereof shall make a *Square?* Divide 100 by 14, it yields $7\frac{1}{7}$ Feet.

§. 1. Now if you have any Number of Feet given, and the Number of *Squares* therein contained are required, divide that Number by 100, the product is *Squares.*

PROP. III.

To measure Paving, Plaistering, Wainscotting, and Painting-work.

In *Paving, Plaistering, Wainscotting,* and *Painting-work, Mechanicks* reckon by the *Yard Square,* so each *Yard* is equal unto 9 *Square Feet.*

By the Rules aforegoing find the *Superficial Content* of the *Court, Alley,* &c. in Feet: which divide by 9, the Quotient is the Number of *Yards* in that work contained.

SECT. II.

§. 2. *Of the Measuring of Timber, Stone, and Irregular Solids.*

IN *Superficial Measure* a *Superficial Foot* contains 144 *Square Inches*; but in *Solid Measure* a *Foot* contains 1728 *Cubick Inches.* Now having already in the fourth Chapter of this Book, and the third Section thereof, largely applyed *Geometry* unto the Measuring of all *regular*

Regular Solids, I ſhall therefore in this Place be as brief as poſſible, only I ſhall be ſomewhat larger in the Menſuration of *Irregular Solids*, which is of ſpecial Moment in ſundry parts of the *Mathematical Practices*. §. 2.

PROP. I.

How to Meaſure any kind of Timber, or Stone, whether Three-ſquare, Four-ſquare, Many-ſquare, Round, or of any other faſhion, provided it be ſtreight and equal all along.

To perform which firſt by the Rules aforegoing in *Chap.* 4. §. 2. get the *Superficial Content* at the End, and then ſay,

As 144, the Inches of the *Superficial Content* of the End of a *Cubick Foot*,

To a Cubick Foot containing 1000 *parts*;

So is the Superficial Content of the End of any piece of *Timber*,

To the Solid Content of one Foot length of the ſaid *piece of Timber*.

According to which Mr. *Phillips* calculated the enſuing Table, which I have thought fit hereunto to annex.

Caſe 2. *Or the ſolid Content in Feet*, &c. *may be found otherwiſe thus.*

By the Rules aforegoing find the Content of the End of the piece of *Timber* in Inches, which Content multiply by the length of the ſaid piece of *Timber*, or *Stone* in Inches, and that *Product* divide by 1728, it produceth the *Solid*

§. 2. *Content* of that Piece of *Timber*, or *Stone*, in Feet, and parts of a Foot.

A Table shewing the Solid Content of one Foot-length of any Piece of Timber, according to the Superficial Content at the End thereof.

The Inches of the Content at the End.	*Feet.*	*Parts.*	*The Inches of the Content at the End.*	*Feet.*	*Parts.*
1	0	007	200	1	398
2	0	014	300	2	083
3	0	021	400	2	778
4	0	028	500	3	472
5	0	035	600	4	167
6	0	042	700	4	861
7	0	049	800	5	556
8	0	056	900	6	250
9	0	062	1000	6	944
100	0	069	2000	13	888
200	1	139	3000	20	833
300	2	208	4000	27	778
400	2	278	5000	34	722
500	3	347	6000	41	666
600	4	417	7000	48	711
700	4	485	8000	55	555
800	5	556	9000	62	500
900	6	625	10000	69	444
1000	6	694	20000	138	888

PROP.

§. 2.

PROP. II.

To meaſure Round Timber which is Hollow: or any other Hollow Body.

If *Hollow Timber* be to be meaſured, firſt meaſure the *Stick* as though it were not *Hollow*, then find the *Solidity* of the *Concavity*, as though it were *Maſſie Timber*, then ſubſtract this laſt found Content, out of the whole Content before found, the remainder is the Content of that *Hollow Body*.

PROP. III.

To Meaſure Tapering Timber, or Stone.

Thoſe *Tapering Bodies* are either *Segments of Cones*, or *Pyramids*: now the way to meaſure ſuch bodies, is demonſtrated in Prop. the 4. and 5. §. 3. Chap. 4: But now to find the Content of theſe *Segments* do thus: meaſure the *Solidity* of the whole *Cone*, or *Pyramid*, and then find the Content of the Top part thereof cut off, (as if it were a *Cone*, or *Pyramid* of it ſelf) and the Content thereof, deduct from the Content of the whole *Cone*, or *Pyramid*: ſo ſhall the remainder be the Content of the *Segment* required: which reduced into Feet gives the Solid Content of that *Piece* of *Timber* in *Feet*. Now to find the length of the *Top part* cut off, from the *Cone*, or *Pyramid*, ſay,

As the Difference of the breadth of the two Ends,
To the length between them:

§. 2. *So is the breadth of the greater End,*
To the whole length of the Cone, or Pyramid.

PROP. IV.

How to find the Solid Content of any Solid Body, in any strange form, such as Geometry can give no Rule for the measuring thereof.

These strange forms are either *Branches* in *Metal*, *Crowns*, *Cups*, *Bowles*, *Pots*, *Screws*, or *Twisted Ballisters*,* or any other *Irregular Solid*, that keep not in thickness one Quantity, but are thicker in one place, than in another, so that no man by *Geometry*, is possible to measure their *Solidity*.

* *Whose Surface is bounded by a Line called by* Proclus *a* Helicoides, *but it may also be called a* Helix, *a Twist or Wreath*, &c.

Now for the finding the Content of any such like *Irregular Body* in Inches or Feet, do thus: Cause to be made a *Hollow Cube*, or *Parallelepipedon*, so that you may measure it with an Inch-Rule without Difficulty, and so to know the true Content of the whole, or any part thereof at pleasure within the *Concavity*: Then take some other convenient Vessel, and put pure Spring-water therein; then having filled the Vessel to a known Measure, make a Mark precisely round the very edge of the Water, then take the *solid body* and put it therein, then take out as much of the Water (as by means of the *body* put therein) is arisen above the Mark, untill the Water do justly touch at the Mark again: then put the Water taken forth into the

Hollow

Hollow Cube, and find the *ſolid Content* thereof (being transformed into a *Cubick Body*) in *Feet*, *Inches*, and parts of an *Inch*: Which Content is the juſt *ſolidity of the Body* put into the Water. (*Archimedes* by this Propoſition found the deceit of the *Crown of Gold* which *Gelo* the Son of *Hiero* had vowed unto his *Gods*: now the Workmen had mixed *Silver* with the *Gold*, which Theft was diſcovered by the great skill of *Archimedes*) *. And herein you muſt be very curious not to ſpill any of the Water, or take out of the Veſſel, or put into the *Hollow Cube*, any more than the juſt quantity ariſen above the Mark, for if you do it will produce infinite Errours, and thus may the *Solidity* of any *Irregular Body* be found. §. 2.

* *See Procl. lib. 2. cap. 3. & Viturvius lib. 9. cap. 3.*

CHAP.

CHAP. XI.

Of GAUGING.

IN *GAUGING* there are two things chiefly neceſſary to be noted, yet both controverted. Firſt, that ſeeing all manner of *Casks*, made to hold *Liquor* in, are for the moſt part the *Trunk* of a *Sphereroid*, cut off with two *Circles*, at *Rightangles* with the *Baſe*, and therefore *Irregular*, Therefore they muſt, firſt be reduced into a *Regular Proportion*. ——And the ſecond thing neceſſary to be noted, is to find the true quantity of an *Ale*, or *Wine-Gallon* in *Cubick-Inches* or parts of a *Foot*, that thereby the Content of the *Veſſel* or *Cask* in *Gallons* may be known.

SECT.

§. 1.

SECT. I.

Of Gauging any Beer, Ale, or Wine-Cask, alſo any manner of Brewers Tuns.

PROP. I.

To find the Solid Content in Inches of any Cask.

I Shall follow Mr. *Oughtred's* method, which is, Take the *Diameter* of the *Cask* both at *Head* and *Bung*, by which find the *Area's* of their *Circles*, which done, then take two thirds of the *Area* of the *Bung*, and one third of the *Area* at the *Head*, which added together, ſhall be the *Mean Area* of the *Cask*; which multiplyed into the length of the Veſſel, it will ſhew how many *ſolid Inches* are contained therein.

Example: Suppoſe the *Diameter* at the Head of a *Veſſel* be 18, and at the *Bung* 32, and length is 40 *Inches*.

Now I find the *Aggregate* of the two *Circles* to be 620, and 989, *Cubick Inches*: which multiplyed by 40, the length, produceth 24839, $\frac{16}{168}$ *Cubick Inches*, for the whole Content of that *Cask* in *Cubick Inches*.

PROP.

§. 1.

PROP. II.

To find the Content of a Veſſel in Wine, or Ale Gallons.

The *Wine Gallon* is eſtabliſhed by the Conſent of *Artiſts*, in theſe and other Nations, to contain 231 *Cubick Inches* *. Yet Dr. *Wybard* affirms it to be ſomewhat leſs, to wit 225, at moſt: The *Ale Gallon* contains 282 *Cubick Inches*, according to the Eſtabliſhment of *Exciſe*. Herein Artiſts differ ſomewhat in their Experiments.

* *See Mr.* Oughthred *in his Book of the Circles of Proportion, page the* 57. *and Mr.* Edm. Gunter *in his Book of the Croſs-ſtaff, part* 21. *chap. the* 4.

Now having already ſhewed how to find the Content in *Inches* of any *Cask*, I now come to ſhew how to find the Content in *Gallons*, of any *Beer*, *Ale*, or *Wine Cask*, which is thus: Divide the Number of Inches given by 231, for *Wine Meaſure*, and 282, for *Ale Meaſure*. In the former Example I find the ſaid *Cask* to contain 107, 53 *Wine Gallons*, and 88, 8, *&c. Gallons* in *Ale Meaſure*.

PROP. III.

How to Gauge or Meaſure Brewers Tuns, &c.

Thoſe Tuns are moſt commonly *Segments* of *Cones* or *Pyramid*, whoſe *Baſis* is either a *Square Parallelogram*, *Circle*, or *Oval*; to meaſure which, let

let their form be what it will you muſt do thus. §. 1.
By the former Rules of Meaſuring ſuch *Segments* or *Bodies*, you muſt find their Solid Content in *Cubick Inches*, (as in prop. 3. §. 2. chap. 10.) which Content divide by 282 Inches, (the *Inches* in one *Gallon*) it ſheweth the Content in *Gallons*, and dividing the *Gallons* by 36, (the number of *Gallons* in a *Barrel*) it ſhews the Content in *Barrels*.

SECT. II.

§. 2.

Of Gauging or Meaſuring, and the Moulding of Ships.

PROP. I.

To Gauge a Ship, thereby to find how many Tuns her burthen is.

IN the *Gauging* or Meaſuring of *Ships*, *Naupegers*, or *Ship-Wrights*, obſerve theſe three Particular Rules: *Firſt*, that if you meaſure the Ship within, you ſhall find the *Content*, or the *Burthen* the Ship will hold or take in. *Secondly*, if the Ship be meaſured on the outſide, to her *light mark* as ſhe ſwims being unladen, you ſhall have the Content of the *Empty Ship*. *Thirdly*, but if you meaſure from the *light mark*, to her *full draught of Water* being *laden*, you ſhall have the true *Burthen* of the Ship. Now

§. 2. Now to find the Content of the *King's Royal Ships*: Meaſure the length of the *Keel*, the breadth of the *Mid-ſhip Beam*, and the *depth of the Hold*: which three multiply into one another, and divide their *Product* by 100; ſo ſhall you find how many *Tuns* her *Burthen* is.

But for *Merchant's Ships*, which give no allowance for *Ordnance*, *Maſts*, *Sails*, *Cables*, *Anchors*, &c. which are all a *Burthen*, but no *Tonnage*, you muſt divide the product by 95, ſo ſhall their true *Burthen* be found.

PROP. II.

By knowing the Meaſure of a Ship, of one Burthen, to make another Ship, of the ſame Mould, which ſhall be double, or triple, or in any proportion, either more or leſs than the ſaid Ship.

Firſt you ſhall multiply the *Keel Cubically*; and in like manner every *Beam*; the *Mid ſhip Beams* multiply them *Cubically*; and alſo the *Reaking* of the *Ship*, both at *Stem*, and *Stem-Poſt*, multiply them *Cubically*; likewiſe the *principal Timbers*, that doth *mould the Ship*, multiply them *Cubically*; and the *depth* of the *Hold*, multiply it *Cubically*; and ſo conſequently every *Place*, or *Places*, which doth lead any work, multiply them *Cubically*; then if it be required to have a Ship as big again, or thrice as big; *double*, or *triple* each reſpective *Cubical number*; then by prop. 9. §. 1. chap. 1: Or by prop. 4. §. 2. chap. 2. find the *Cube-roots* thereunto belonging; then according unto theſe reſpective Numbers, make your *Keel*, your *Timbers*, *Beams*, *&c.* which being done, you ſhall make a Ship of the Mould and Proportion deſired.

CHAP.

CHAP. XII.

Of DIALLING.

HOROLOGIOGRAPHIA, *or the Art of* DIALLING, *is an Art Mathematical, which demonſtrateth the preciſe Diſtinction of Times, by the Sun, Moon and Stars, whereby the Time of the Day, or Night, may be known* *. Now the Demonſtrative delineation of *Dials*, conſiſteth chiefly in the finding out the *Hour-lines*, and their true diſtance one from the other: which lines are *great Circles* of a *Sphere*, which being projected on a *plain Superficies*, become ſtreight-lines; which lines do continually vary, according as the *Planes* on which they are deſcribed, or projected, do lie ſituated in reſpect of the *Horizon* of the Place. Now

* *Which doth appear to have been in uſe above this* 2400 *Years, for King* Achaz *had a Dial: This Art requireth good skill in Geometry, and Aſtronomy: Now* Cteſibius *that famous Philoſopher meaſured the Hours and Times by the orderly running of Water. Then by Sand was the Hours meaſured. After that by* Trochilike *with Weights, and of late with* Trochilike *with Springs.*

Now a *Dial* may be made on any *Plain Superficies*, for all *Plain Superficies* are Posited either *Perpendicular*, *Parallel*, or *Oblique*, to the *Horizon* of the Place, in which the *Plane* is seated.

In the delineation of all which *Dials* in this Chapter described, (which are the most Eminent, and usefull Dials now used) I have used this Method: *First*, I have shewed how to delineate them by *Geometrical Projection*, by *Scale*, and *Compass* only: and *secondly* how they may be described by *Arithmetical Calculation*, of both which I have been very plain and large.

SECT. I.

§. 1. *Of the Delineation and Projection of sundry most usefull Dials.*

PROP. I.

How to draw the Hour-lines on an Equinoctial Plain.

AN *Equinoctial Plane*, is such which lieth *Parallel* unto the *Equinoctial*, and is an *Horizontal Plane*, under the *Pole*. This is the first and plainest kind of *Dials*, and is made after this manner: First describe the *Circle* Æ, W, E, R, for your Planes, then Cross it with the two *Diameters* EW, and ÆR. Then divide the *Semicircle* E, W, R, into 12 equal parts in the points ⊙, ⊙, ⊙, &c. Then from the *Center* Q, and through the said points draw

Fig. 64.

draw ſtreight lines, which ſhall be the true *Hour-lines* belonging unto this *Equinoctial Plane*. Now becauſe theſe *Planes* are capable of receiving all the *Hour-lines* from *Sun-riſing* unto the *Sun-ſetting*, in *Summer*; therefore the *Hour-lines* of 4, and 5, in the *Morning*; and 7, and 8, in the *Evening*; muſt be delineated as you ſee done in the *Figure*: Theſe Hours may be ſub-divided into *half Hours*, and *Quarters*: The *Stile* of this *Dial*, muſt be a ſtreight *Pin*, or *Wyre* ſet *Perpendicular*, to the *Plain*, on the *Center* Q, and of any convenient length. This Dial may be made for any Latitude, and is of good uſe for Seamen, and others. §. 1. *Fig.* 64.

PROP. II.

How to draw the Hour-lines on a Polar Plane.

A *Polar Plane* is one that lies *Parallel* unto the *Pole*, and under the *Equinoctial* is an *Horizontal Dial*: the way to make this Dial is thus. *Firſt* draw the line AB, for the *Horizontal line* of the *Plane*; and croſs it at the Middle at *right angles*, with the line 12, Q, 12, which is the *Meridian* or Hour line of 12; Then upon the line 12, Q 12, either above or below the point Q, aſſume any point as S, then ſetting one foot of your Compaſſes in S, deſcribe the *Semicircle* CED, which divide into 12 Equal parts, in the points ⊙, ⊙, ⊙, *&c.* Then lay a Ruler unto S, and unto the ſeveral points ⊙, ⊙, ⊙, *&c.* and it will croſs the line AB, in the points x, x, x, *&c.* Then through thoſe points draw (by prop. 4. §. 1. chap. 4.) right lines all *Parallel* *Fig.* 65.

§ 1. unto 12 Q 12, and ſo is your Dial finiſhed. Then according unto the breadth of the *Plane*, you may proportion your *Stile*, *Whoſe height muſt be equal to the diſtance between the two Hour-lines 12, and 9, or 12, and 3, and then will the ſhadow of the upper edge thereof ſhew the Hour of the day: The height of the *Stile*, is alſo found thus.

Fig. 65.

* *Which may be either a* Pin *of the length of* Q S, *placed on* Q, *and* Perpendicular *unto the* Plane, *or it may be a* piece of braſs *or elſewhat of the breadth of* 12, *to* 3, *or* 9.

As the Tangent of the Hour-line 4 *or* 5,
To the Diſtance thereof from the Meridian.
So is the Radius,
To the Height of the Stile.
Then for the other *Hour-line*, ſay,
As the Radius,
To the Height of the Stile.
So is the Tangent of any other Hour-line,
To the Diſtance thereof from the Meridian line.

PROP. III.

How to draw the Hour-lines on a Meridian Plane, which is an Eaſt, or Weſt Dial.

A *Meridian Plane* ſtands upright directly in the *Meridian*, and hath two Faces, one towards the *Eaſt*, and the other towards the *Weſt*.

Now admit it be required to make a direct *Eaſt Dial*, in the *Latitude* of 51° 32′: let A, B, C, D, be a *Dial-plane*, on which you would deſcribe a *Direct Eaſt Dial*, on the point D, deſcribe

Fig. 66.

ſcribe an *obſcure Arch* HG, with the *Radius* of your line of *Chords*, then take 38° 28′, the *Complement* of your *Latitude*, place it from G to L; then draw DL quite through the *Plane*; Then to proportion your *Stile* unto your *Plane*, ſo that all the Hours may be placed thereon, from *Sun-riſing* to 11 *a Clock*. Aſſume two points in the line LD, as K, for 11; and I for the 6 *a Clock* Hour-lines; then draw 6, I 6, and 11, K 11, *Perpendiculur* to LD. This done, with the *Radius* of your *line of Chords* on L, ſtrike the *Arch* OP, and from P, to O, place 15° 00′; and draw OK, to cut 6 I 6, in M, ſo ſhall IM be the height of the *Stile* proportioned unto this *Plane*; which may be a Plate of *Braſs*, whoſe breadth muſt be equal to the diſtance between the Hour-lines of 6, and 9, which muſt be placed *Perpendicular* to the *Plane*, on the line 6, I 6, whoſe ſhadow of the upper edge, ſhall ſhew the Hour of the day. Now to draw the Hour-lines, with the *Radius* of your *line of Chords*, on M ſtrike the *Arch* QN, which divide into 5 equal parts in the points ●, ●, ●, *&c.* Then lay a Ruler from M unto each of thoſe points, and it will cut the line IK in the points *, *, *; *&c.* through which points (by *prop.* 4. § 1. *chap.* 4.) draw Parallels to 6 I 6, as the lines 77, 88, *&c.* which ſhall be the true Hour-lines of an Eaſt *Plane*, from 6 in the Morning, till 11 before *Noon*. Then for the *Hour-lines* of 4, and 5, you muſt prick off 5 as far from 6, as 6 is from 7; and 4, as far as 6 is from 8; and draw the *Hour-lines* 55, and 44, as before. Thus is your *Dial* compleated, and in the forming of which, you have

§. 1.

Fig. 66.

Fig. 66.

§ 1. unto 12 Q 12, and ſo is your Dial finiſhe
Then according unto the breadth of the *Pla*
Fig. 65. you may proporti
your *Stile*, * Whoſe heig
muſt be equal to the
ſtance between the tv
Hour-lines 12, and 9,
12, and 3, and then w
the ſhadow of the upp
edge thereof ſhew t
Hour of the day: T
height of the *Stile*, is alſo found thus.

As the Tangent of the Hour-line 4 *or* 5,
To the Diſtance thereof from the Meridian.
So is the Radius,
To the Height of the Stile.
Then for the other *Hour-line*, ſay,
As the Radius,
To the Height of the Stile.
So is the Tangent of any other Hour-line,
To the Diſtance thereof from the Meridian line.

* *Which may be either a* Pin *of the length of* Q S, *placed on* Q, *and* Perpendicular *unto the* Plane, *or it may be a* piece of braſs *or elſewhat of the breadth of* 12, *to* 3, *or* 9.

PROP. III.

How to draw the Hour-lines on a Meridian Plane, which is an Eaſt, or Weſt Dial.

A *Meridian Plane* ſtands upright directly in the *Meridian*, and hath two Faces, one towards the *Eaſt*, and the other towards the *Weſt*.

Now admit it be required to make a direct
Fig. 66. *Eaſt Dial*, in the *Latitude* of 51° 32′: let A, B, C, D, be a *Dial-plane*, on which you would deſcribe a *Direct Eaſt Dial*, on the point D, deſcribe

ſcribe an *obſcure Arch* HG, with the *Radius* of your line of *Chords*, then take 38° 28′, the *Complement* of your *Latitude*, place it from G to L; then draw DL quite through the *Plane*; Then to proportion your *Stile* unto your *Plane*, ſo that all the Hours may be placed thereon, from *Sun-riſing* to 11 *a Clock*. Aſſume two points in the line LD, as K, for 11; and I for the 6 *a Clock* Hour-lines; then draw 6, I 6, and 11, K 11, *Perpendiculur* to LD. This done, with the *Radius* of your *line of Chords* on L, ſtrike the *Arch* OP, and from P, to O, place 15° 00′; and draw OK, to cut 6 I 6, in M, ſo ſhall IM be the height of the *Stile* proportioned unto this *Plane*; which may be a Plate of *Braſs*, whoſe breadth muſt be equal to the diſtance between the Hour-lines of 6, and 9, which muſt be placed *Perpendicular* to the *Plane*, on the line 6, I 6, whoſe ſhadow of the upper edge, ſhall ſhew the Hour of the day. Now to draw the Hour-lines, with the *Radius* of your *line of Chords*, on M ſtrike the *Arch* QN, which divide into 5 equal parts in the points ●, ●, ●, *&c.* Then lay a Ruler from M unto each of thoſe points, and it will cut the line IK in the points *, *, *; *&c.* through which points (by *prop.* 4. § 1. *chap.* 4.) draw Parallels to 6 I 6, as the lines 77, 88, *&c.* which ſhall be the true Hour-lines of an Eaſt *Plane*, from 6 in the Morning, till 11 before *Noon*. Then for the *Hour-lines* of 4, and 5, you muſt prick off 5 as far from 6, as 6 is from 7; and 4, as far as 6 is from 8; and draw the *Hour-lines* 55, and 44, as before. Thus is your *Dial* compleated, and in the forming of which, you have

§. 1.

Fig. 66.

Fig. 66.

§. 1. made both an *Eaſt*, and a *Weſt Dial*; which is the ſame in all reſpects, only whereas the *Arch* H G, through which the *Equinoctial* paſſed in the *Eaſt Dial*, was deſcribed on the right hand of the *Plane*, in the *Weſt* it muſt be drawn on the left hand, and the *Hour-lines* 4, 5, 6, 7, 8, 9, 10, and 11, in the *Forenoon* in the *Eaſt Dial*, *Fig.* 67. muſt be 8, 7, 6, 5, 4, 3, 2, and 1, in the *Weſt* in the *Afternoon*; as in the *Figure* plainly appeareth: Now you may find the diſtance of the *Hour-lines* from the *Subſtile*, by this *Analogy* or *Proportion*.

As the Radius,
To the Height of the Stile.
So is the Tangent of any Hours diſtance from 6,
To the diſtance thereof from the Subſtile.

PROP. IV.

How to draw the Hour-lines on a direct South, and North Plane,

This *Plane* or *Dial* muſt ſtand upright, having his face or *Plane*, if it be a *South Dial*, directly oppoſite unto the *South*; but if a *North Plane*, directly oppoſite unto the *North*; now *Fig.* 68. admit it be required to make a *Direct South Dial*, for the *Latitude* of 51° 32′: To make which firſt deſcribe the *Circle* ABCD, to repreſent an *Exact direct South Plane*, croſs it with the *Diameters* CB, and AD, then out of your *Line of Chords* take 38° 28′, the *Complement* of the *Latitude*, and ſet it from A, unto a, and from B, unto b, Then lay a Ruler from C unto a, and it will cut the *Meridian* ARD, in P, the *Poles* of the

§. 1

Fig.

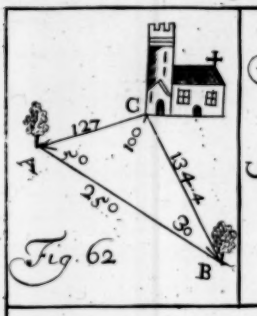


Fig. 62

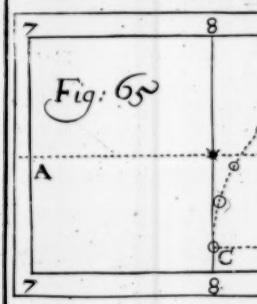


Fig: 65

Fig.

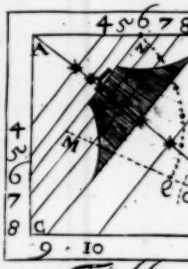


Fig: 66

§. 1.

Fig. 63

Fig. 64

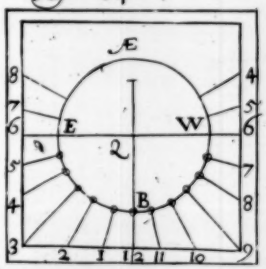


Fig. 68.

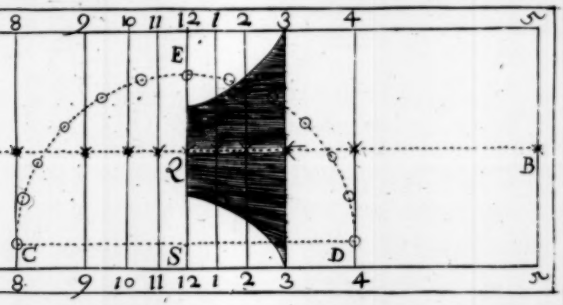
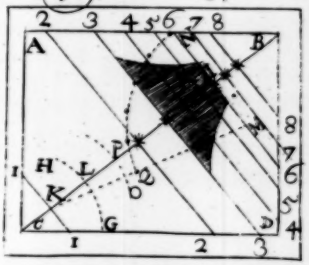


Fig. 67



69.

§. 1. other hath the *North Pole* of the *World* elevated above it, and beholdeth the *North part* of the *Meridian*. The *Hour-lines* of 9, 10, 11, or 1, 2, and 3, is not expreſſed on this *Plane*, becauſe 12, repreſenteth 12, at *Midnight*; neither are the other ſaid Hours expreſſed, becauſe the *Sun* is never above the *Horizon*, at thoſe Hours;

Fig. 69. Therefore the *North Dial* is capable only to receive theſe *Hours*, namely 4, 5, 6, 7, and 8, in the *Morning*; and 4, 5, 6, 7, and 8, at *Night*; as doth plainly appear in the Figure: Now the diſtance of the *Hour-lines* from the *Meridian*, may be found by this *Analogy*, or *Proportion*.

As Radius or S. 90°,
To Sc. *of the Latitude.*
So is T. *of the Hour from Noon,*
To T. *of the Hour-line from the Meridian.*

PROP. V.

How to draw the Hour-lines on an Horizontal Plane.

This *Horizontal Plane*, or *Dial*, is one of the beſt and moſt uſefull *Dials* in our *Oblique Hemiſphere*: Admit it be required to make an *Horizontal Dial*, for the *Latitude* of 51° 32′:

Fig. 70. To make which, firſt deſcribe the Circle AB CD, which repreſenteth your *Horizontal Plane*, Then croſs it with the two *Diameters* ARC, and BRD, Then take 51° 32′ out of your *Line of Chords*, and ſet it from B, to a, and from C, to b, Then lay a *Ruler* from A, unto a, and it will cut the *Meridian* BD, in P, the *Pole* of the *World*,

World, Then lay a *Ruler* from A, unto b, and it will cut ABD the *Meridian*, in the point Æ, where the *Equinoctial* cutteth the *Meridian*, then through the three points A, Æ, and C, draw the *Equinoctial Circle*, whoſe Center is at H; (and found as in the former propoſition) Then divide the *Semicircle* ADC into 12 equal parts, in the points ●, ●, ●, *&c.* Then lay a *Ruler* to R the *Center* of the *Plane*, and on thoſe points, ſo ſhall the *Equinoctial Circle* AÆC, be by it divided into 12 unequal parts in the points *, *, *, *, *&c.* Then a *Ruler* laid unto P the *Pole* of the *World*, and thoſe Points, ſhall cut the *Semicircle* CDA in thoſe Points I, I, I, *&c.* Laſtly, from the *Center* R, and through thoſe Points, let there be drawn right lines, which ſhall be the true *Hour-lines* of ſuch an *Horizontal Plane*, from 6 in the Morning, untill 6 at Night; but for the Hours of 4 and 5 in the Morning; and 7 and 8 in the Evening; they are delineated by producing 4 and 5 in the Evening, through the *Center* R, and 7 and 8 in the Morning; extending them out, unto the other ſide of the *Plane*, ſo ſhall you have thoſe *Hour-lines* alſo on your *Plane* delineated as you ſee in the *Figure*. The *Stile* of this *Plane* may be a thin Plate of *Braſs*, cut exactly unto the Quantity of an Angle of 51° 32′, and ſet *Perpendicular* on the *Meridian line*, for the forming of this *Stile* take out of your *Line of Chords* 51° 32′, and ſet it from D, unto e, and draw Re, which ſhall be the *Axis* of the *Stile*, you may alſo prefix the *Halves*, and *Quarters* of *Hours*, in the very ſame manner as the *Hours* themſelves were drawn.

§. 1. *Fig.* 70. *Fig.* 70.

§. 1. Now to find out the distance of the *Hour-lines* from the *Meridian*, say,

As the Radius or S. 90°,
To the S. *of the Latitude.*
So is the T. *of the Hour from Noon,*
To the T. *of the Hour-line, from the Meridian Line.*

Fig. 70. These kinds of *Dials* being so frequently used with us, in this *Oblique Sphere*, for the help of the speedy delineating of them, I have annexed hereunto the Table of *Longomontanus*, wherein the *Hour-lines*, for many *Latitudes*, are calculated.

A Table

§. 1.

A Table shewing the Distance of the Hour-lines from the Meridian, in these Degrees of Latitude.

An Horizontal Dial, Latitude.	The Hours from the Meridian.												A South Erect Dial, Latitude.
	xi.		i. x.		ii. ix.		iii viii.		iv. vii		v.	vi.	
	D	M	D	M	D	M	D	M	D	M	D M	D M	
30	7	38	16	6	26	34	40	54	61	49	90	00	60
31	7	51	16	34	27	14	41	42	62	28	90	00	59
32	8	4	17	1	27	53	42	30	63	6	90	00	58
33	8	17	17	27	28	34	43	17	63	45	90	00	57
34	8	30	17	54	29	13	44	5	64	42	90	00	56
35	8	43	18	20	29	49	44	46	64	56	90	00	55
36	8	56	18	45	30	25	45	28	65	27	90	00	54
37	9	9	19	9	31	1	46	9	65	58	90	00	53
38	9	21	19	34	31	37	46	50	66	29	90	00	52
39	9	33	19	57	32	9	47	26	66	55	90	00	51
40	9	46	20	20	32	40	48	1	67	20	90	00	50
41	9	58	20	43	33	14	48	37	67	45	90	00	49
42	10	10	21	7	33	47	49	13	68	11	90	00	48
43	10	22	21	29	34	17	49	44	68	32	90	00	47
44	10	24	21	50	34	46	50	14	68	52	90	00	46
45	10	43	22	12	35	15	50	45	69	14	90	00	45
46	10	54	22	33	35	44	51	16	69	37	90	00	44
47	11	5	22	33	36	10	51	43	69	53	90	00	43
48	11	16	23	12	36	35	52	9	70	10	90	00	42
49	11	26	23	32	37	1	52	35	70	28	90	00	41
50	11	36	23	51	37	27	53	1	70	43	90	00	40
51	11	46	24	9	37	50	53	24	70	58	90	00	39
52	11	56	24	26	38	13	53	46	71	12	90	00	38
53	12	5	24	44	38	36	54	8	71	27	90	00	37
54	12	14	25	2	38	59	54	30	71	41	90	00	36
55	12	23	25	18	39	18	54	50	71	53	90	00	35
56	12	32	25	33	39	38	55	9	72	4	90	00	34
57	12	46	25	49	39	58	55	28	72	16	90	00	33
58	12	48	26	5	40	18	55	46	72	27	90	00	32
59	13	56	26	19	40	36	56	1	72	38	90	00	31
60	13	58	26	30	40	53	56	15	72	47	90	00	30

§. 1.

PROP. VI.

How to draw the Hour-lines, on an Erect declining Plane.

Theſe *Planes* are made to ſet on the ſides of *Houſes*, wherein the *Meridian* is always a *Perpendicular*, drawn on the *Plane*, in whoſe top is the *Center*, where the *Subſtile*, and the *Hour-lines* all meet. *Fig.* 71.

Now before we can delineate the *Hour-lines* on any ſuch *Planes*, two things muſt be given: *As the Latitude of the Place*, and *the Planes Declination*; by having which we muſt find theſe three things: *viz. The Poles height above the Plane. The diſtance of the ſubſtile from the Meridian. And the Plane's difference of Longitude.*

For the finding of which *Requiſites*, by *Geometrical Projection*, we deſcribe on the *Dial Plane*, theſe Circles of the *Sphere*, *viz.* The *Horizon*, *Meridian*, and *Equinoctial*, which being deſcribed in their true Poſition, on the *Plane*, we proceed thus. *Fig.* 71.

Admit it be required to make a *Direct South Dial*, on an *Erect*, *Direct South Plane*, *Declining Weſtward* 24° 20′, in the *Latitude* of 51° 32′.

Now in order to find the requiſites before mentioned, deſcribe the *Circle* ZHNO, and croſs it with the two *Diameters* ZQN, and HQO: now Z is the *Zenith*, N the *Nadir*, ZQN the *Hour-line* of 12, HQO the *Horizon*. Now ſeeing the *Plane* declines S. W. 34° 20′: make N a, and O b, each equal to 34 20: Then a *Ruler* layed from Z, to a, will cut the *Horizon* in S, the South

South point of the *Horizon*, throughwhich draw the *Meridian* ZSN, whose Center is at Y, found as in the fourth Proposition aforegoing: Then a Ruler laid from Z to b, will cut the *Horizon* in W, the West point thereof. Now the *Horizon* and the *Meridian* being projected on the *Plane*, take out of your line of *Chords* 51° 32′, which place from H, unto c, and from N, unto d; then lay a Ruler from W, unto c, and it cutteth the *Meridian* in P, the *Pole* of the *World*. Then through P and Q, draw the line PQD, which representeth the *Axis* of the *World*; and the *Substilar line* of the *Dial*, then lay a Ruler from W, to d, it cutteth the *Meridian* in Æ, so is WÆ two points through which the *Equinoctial* must pass, whose *Center* is found as afore to be at M, (being always in the *Axis* of the *World*) so have you on your Plane the *Horizon* HQO, the *Meridian* ZPSÆ N, and the *Equinoctial* LÆKWG, described on the *Plane* as required. §. 1. *Fig.* 71.

Now *first* to find the *Poles height above the Plane*, which in this *Scheme* is represented by BP, Lay a Ruler from G, unto P, and it shall cut the *Plane* in V, then measure the distance BV, on your line of *Chords*, and you will find it to contain 34° 33′, which is the *Poles height above the Plane*. *Fig.* 71.

Secondly, To find *the distance of the Substile from the Meridian* represented in the *Scheme* by the *Arch* ZB, or ND, which measured as afore will appear to be 18° 08′, the distance of the *Substile* from the *Meridian*.

Thirdly, To find *the Plane's Difference of Longitude*, which in the *Scheme* is represented by the

§. 1. the *Angle* ÆPK, lay a Ruler from P, unto Æ, and it cutteth the *Plane* in X, then measure the *Arch* DX, as afore, and so will you find the *Planes Difference of Longitude*, to be 30° 00′: Fig. 71. Thus by *Geometrical Projection* have we found all the three *Requisites*: Now to find them by *Arithmetical Calculation* observe these *Analogies* or *Proportions*.

1. *For the Poles height above the Plane*, say,
As Radius or S. 90°,
To Sc. *of the Latitude* 38° 28′.
So is Sc. *of the Declination* 65° 40′,
To S. *of the Poles height above the Plane* 34° 33′.

2. *For the Distance of the Substile, from the Meridian*, say,
As the Radius or S. 90° 00′,
To the S. *of the Plane's Declination* 24° 20′.
So is Tc. *of the Latitude* 38° 28′,
To the T. *of the Substilar Distance from the Meridian* 18° 10′.

3. *For the Plane's Difference of Longitude*, say,
Fig. 71. *As the* Sc. *of the Latitude* 38° 28′,
To the Radius or S. 90° 00′.
So is S. *of the Substilar Distance* 18° 10′,
To the S. *of the Difference of Longitude* 30 *Deg.*

Or, *it may be found thus.*
As the S. *of the Latitude*,
To the Radius.
So is the T. *of the Declination*,
To the T. *of the Difference of Longitude* required.

These

Theſe things found, we come now to ſhew how the *Hour-lines* may be projected. To project which obſerve, Firſt, to lay a Ruler from P the *Pole* of the *World*, to Æ the *Interſection* of the *Equinoctial* with the *Meridian*, and it will cut the *Plane* in x, where begin to divide the *Semicircle* L x G, into 12 Equal parts in the Points ●, ●, ●, ●, *&c.* Then lay a Ruler from Q, to every of thoſe parts, and it ſhall cut the *Equinoctial*; and divide it into 12 unequal parts, in the points *, *, *, *, *&c.* Then a Ruler laid from P the *Pole* of the *World* unto each of theſe points, it will divide the *Plane* into 12 unequal parts in the Points I, I, I, I, *&c.* Then by a Ruler laid from the *Center* Q, to thoſe points, draw right lines, which ſhall be the *true Hour-lines* proper unto ſuch a *Declining Plane*, as you ſee plainly demonſtrated by the *Scheme.* §. 1. *Fig.* 71.

Now the *Subſtilar line* falleth in this *Dial*, juſt on the *Hour-line* of 2, in the Afternoon, becauſe the *Plane* declineth *Weſterly.* The *Angle* of the *Stile* is DQR 34° 33′. which may be either a *Plate* or *Wyre*, brought into ſuch an *Angle*, which muſt be placed *Perpendicular* to the *Plane*, and directly over the *Subſtilar line* QD 2.

Now the diſtance of the *Hour-lines*, from the *Subſtilar line*, may alſo be found by this *Analogy* or *Proportion.*

As the Radius,
To the S. *height of the Pole above the Plane.*
So is the T. *of the Hour-line from the Meridian of the Plane,*
To the T. *of the Hour-line from the Subſtile.* *Fig.* 71.

Thus

§. 1. Thus have you compleated your *Dial*; as you see in the *Scheme*, and here you may take notice that having finished a *West Decliner*, you have also made an *East Decliner*; if you only convert the *Hour-lines* of the *West Decliner*, in *Fig.* 72. such manner as you see in *Fig.* 72. on the *East Decliner*, and compleat all as you see in that *Scheme*.

Thus I have explained the making and delineating of the best and most usefull *Dials* both by *Geometrical Projection*, and also by *Arithmetical Calculations*, in as brief and compendious a manner as possible. There are sundry other kind of *Dials*, as *Incliners*, *Decliners*, and *Recliners*, which being not so usefull, for brevity sake, they are here omitted: As for *Instrumental Dials*, as *Quadrants*, *Rings*, *Cylinders*, *&c.* Which depend on the Sun's height, I refer you to Mr. *Edm. Gunter's* Book, wherein *they* are largely described.

As for the Beautifying and Adorning of those *Dials*, &c. by describing on them the *Equinoctial*, *Tropicks*, *Parallels of Declination*, *Parallels of the Sun's Place*, *Length of Days*, *the Sun's Rising* and *Setting*, *Jewish*, *Italian*, and *Babylonish Hours*, *Almicanthars*, *Azimuths*, *Circles of Position*, the *Signs Right Ascending*, *Descending*, *Culminating*, &c. I do advise you to consult Mr. *Gunter*, Mr. *Foster*, Mr. *Wells*, and Mr. *Holwel's Works*, all which Authors have very learnedly shewed the describing of them, by several large *Schemes*, and *Figures*, for the plainer Illustration thereof.

Now seeing the *Latitude* of a Place must be first known, before a *Dial* can be made to it, I have

§. 1.

Fig. 72.

Fig: 68

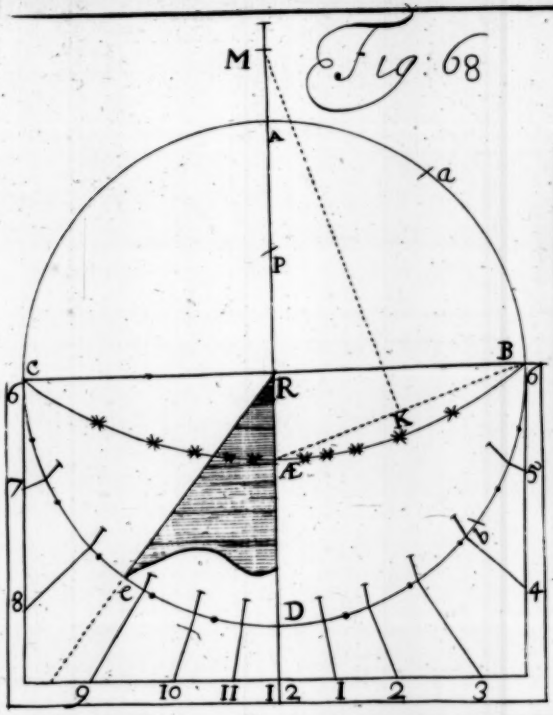


Fig: 69

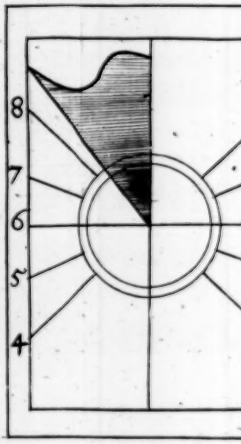


Fig: 71.

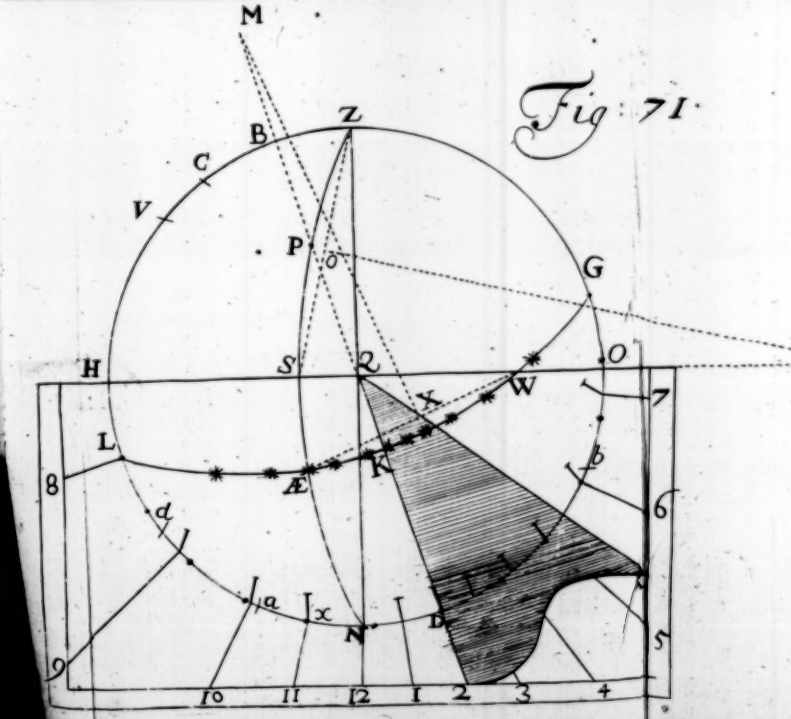


Figure 70

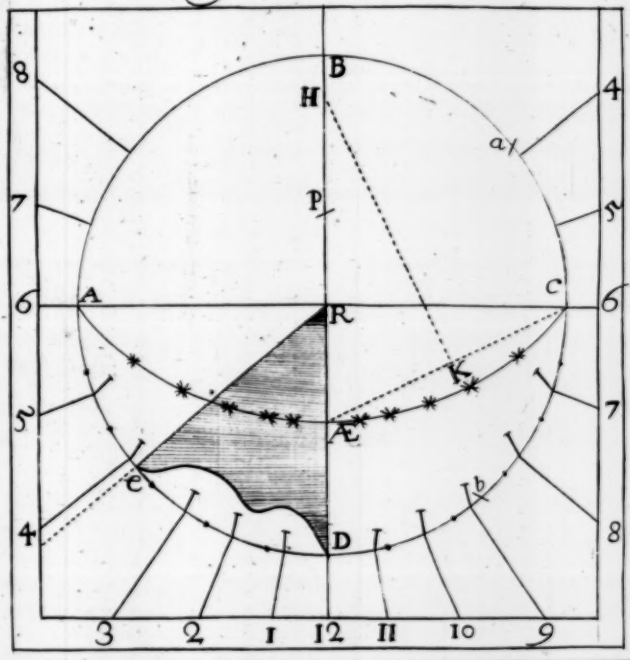
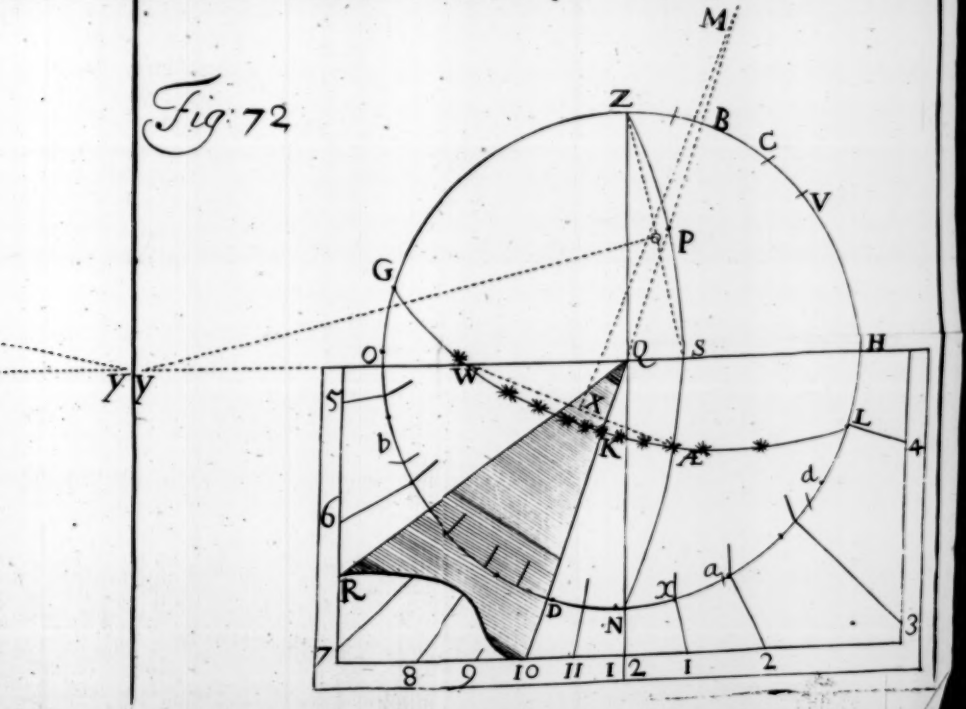
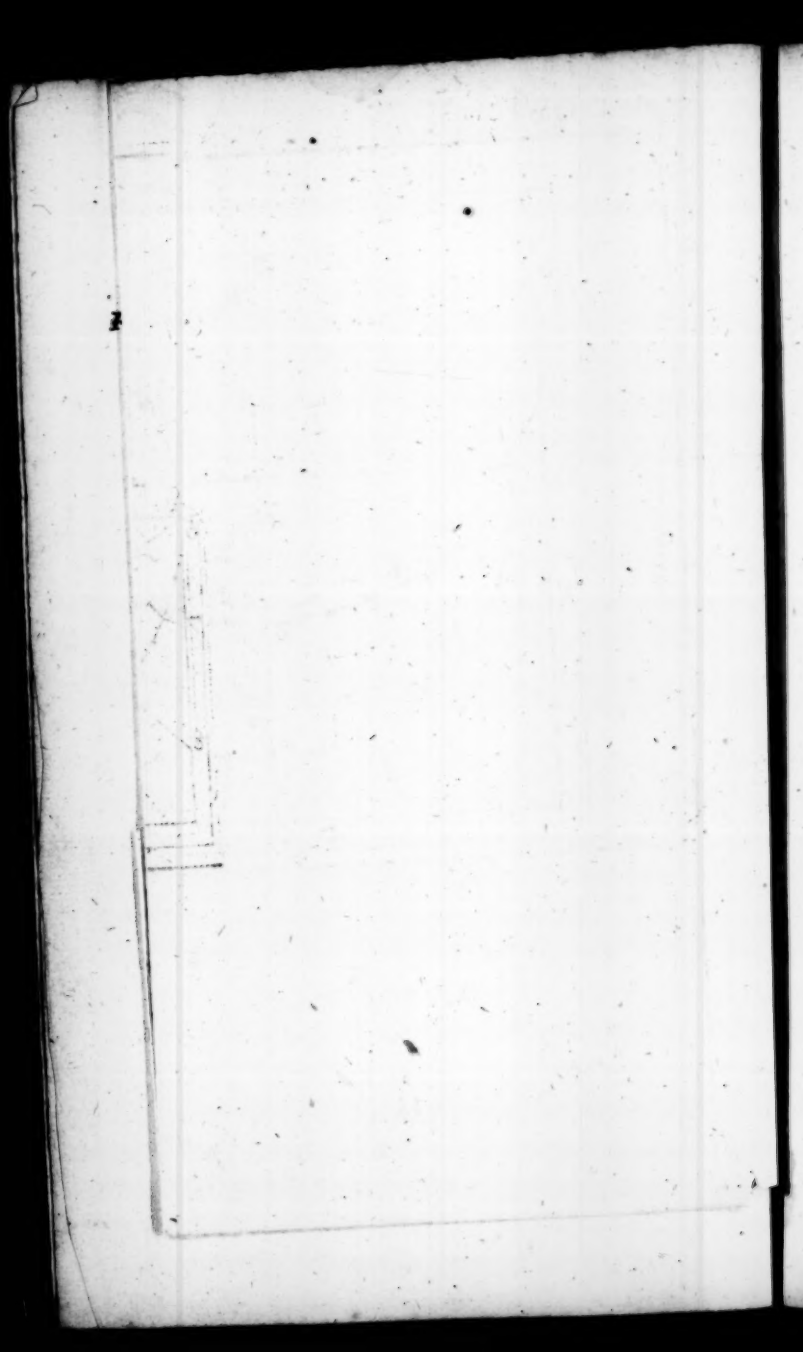


Fig. 72





I have therefore hereunto annexed a Table of the *Latitudes* of all the principal *Cities*, *Towns*, and *Iſlands*, in and about *Great Britain* and *Ireland*; ſo that if you are to make a *Dial*, for any of thoſe parts, you may have recourſe to this Table, and make your *Dial* to the Latitude of that place, which you find to be the neareſt to the Place, for which you are to make your *Dial*. §. 1.

A Table of the Names and Latitudes of all the Principal Cities, Towns, and Iſlands, in and about Great Britain *and* Ireland.

ENGLAND.

	D.	M.
Arundel	51	00
Bedford	52	15
Barwick	55	54
Briſtol	51	35
Buckingham	52	10
Cambridge	52	20
Canterbury	51	25
Carliſle	55	20
Chicheſter	50	48
Cheſter	53	18
Colcheſter	52	08
Dover	51	20
Derby	53	00
Dorcheſter	50	50
Durham	54	56
Exeter	50	48
Falmouth	55	22
Gloceſter	51	57
Guilford	51	12
Hartford	51	54
Hereford	52	17
Huntington	52	30
Ipſwich	52	20
London	51	30
Lincoln	53	20
Leiceſter	52	45
Lancaſter	54	15
Northampton	52	24
Norwich	52	45
Nottingham	53	00
Newcaſtle	55	12
Oxford	51	50
Portſmouth	51	08
Plimouth	50	36
Reding	51	40
Salsbury		

§. 1.

	D.	M.
Salsbury	51	12
Stafford	52	50
Stanford	54	44
Shrewsbury	52	50
Truero	50	30
Wincheſter	51	03
Worceſter	52	25
Warwick	52	30
York	54	00

WALES.	D.	M.
Angleſey	53	28
Barmonth	52	50
Brecknock	52	01
Cardigan	52	12
Caermarthen	51	56
Carnarvan	53	16
Denbigh	53	13
Flint	53	17
Landaffe	51	35
Monmouth	51	51
Montgomery	51	56
Pembroke	51	46
Radnor	52	19
St. *David*	52	00

SCOTLAND.	D.	M.
Berdeen	57	30
Dunblain	56	21
Dunkel	56	48
Edenbrough	56	00
Glaſcow	55	58
Kinſaile	57	44
Orkney	60	06
St. *Andrews*	56	40
Skyraſſin	58	38
Sterling	56	12

IRELAND.	D.	M.
Antrim	54	38
Arglas	54	10
Armagh	54	14
Carterlagh	52	41
Clare	52	34
Corke	51	55
Droghedagh	53	58
Dublin	53	55
Dundalke	53	52
Galloway	53	02
Kenney	52	30
Kildare	53	00
Kings Town	53	08
Knockfergns	54	40
Kynſale	51	41
Lymerick	52	30
Queens Town	52	52
Waterford	52	09
Wexford	52	18
Youhall	51	53

ISLANDS.	D.	M.
Wight	50	48
Portland	50	30
Man	54	24
Limdey	51	22
Jerzey	49	12
Garnzey	49	03

CHAP.

CHAP. XIII.

Of FORTIFICATION.

THE *Utility of this Mathematical Art called Fortification, or Military Architecture, is ſo well known, that it needs not my commendation, and therefore to ſpeak any thing thereto, were but to light a Candle before the Sun.*

In the handling of this part of the *Mathematicks*, I ſhall be as brief as poſſible, yet as plain as can be deſired: In the proſecution of which, I ſhall uſe this Method. As *Firſt*, I ſhall give you the moſt principal *Definitions* or *Terms* belonging to this Art. *Secondly*, I ſhall preſcribe the moſt conducing *Maxims* or Rules herein obſerved. *Thirdly*, I ſhall ſhew how to delineate the Ground-line of any *Fortification*, according to the ſeveral Proportions, uſed by the beſt and moſt experienc'd Inginiers of *Italy*, *France*, *Holland* and *England*; *Fourthly*, I ſhall deſcribe the Conſtruction of the chief and principal Outworks now in uſe; and *Laſtly*, lay down ſome general *Maxims* or *Rules*, by moſt *Modern Authors* obſerved in *Irregular Fortifications*.

SECT. I.

§. 1. *Of the Definitions of the Lines, and Angles, belonging to the Principal Ground work of any Regular Fortification.*

Defin. 1. THE *Exterior* or outward Line, which boundeth the *Rampart*, at the Foot next the *Ditch*, is the principal and only Line to be regarded in all *Regular*, or *Irregular Fortifications*, being the *Basis* on which all the other Lines, and parts of the *Fortification* doth depend.

2. The *Exterior Polygon*, is the outward side of any *Regular Figure*, as in the *Hexagon* (which Figure I shall make use of through this Tract) the side AA, is the *Exterior Polygon*.

Fig. 73. 3. The *Interior Polygon*, is the inward side of any Regular Figure, as in the *Hexagon* is noted by any of the sides between P and P.

4. The *Bastion* or *Bulwork*, is that great work of any *Fort*, that advanceth its self towards the *Campaigne*, and here are six all marked with B, the lines which terminate them, are two *Gorges*, two *Flanks*, and two *Faces*.

Fig. 73. 5. The *Demi-Gorge* or *Gorge*-line PC, is half the Entrance into the *Bastion*, and terminates the point C, whereby the *Flank* shall be raised.

6 The *Flank* is another Out-line of the *Bastion* as CF, which terminateth the *Curtain*, and *Face*.

7. The

7. The *Face* is the utmoſt line of the *Baſtion*, as FA, two lines thereof doth form the Angle of the *Baſtion* A, or the *Flanked Angle*. §. 1.

8. The line forming the *Flank* FF, is a pricked line, made uſe of by the *Dutch Inginiers*, and others.

9. The *Capital* is AP, part of the line coming from the Center ⊙, terminated at the point of the *Baſtion* A. *Fig.* 73.

10. The *Curtain* is that part of the *Interior Polygon* CC, which lieth betwixt the two *Baſtions* B, and B.

11. The line of *Defence* is AC, paſſing from A, the point of the *Baſtion*, to C the *Angle* of the *Flank*, and *Curtain*, and ought never to exceed 800 Engliſh Feet *. *Fig.* 73.

* *Becauſe the length of the part of a Musket doth not much exceed that Meaſure.*

12. The line *Stringent*, is the line coming from the point of the *Baſtion* A, and prolonged on the *Face* AF, to the *Curtain* D, which ſheweth that DC, the part of the *Curtain*, (by ſome called the *ſecond Flank* will ſcour the *Face*.

13. The *Diameter* of the *Interior Polygon*, is the line ⊙P, coming from the Center thereof ⊙.

14. The ſhorteſt line from the Center unto the *Curtain*, is ⊙m. Theſe are the *Definitions* of the principal lines, appertaining to the Groundwork of any *Regular Fortification*, the *Angles* followeth.

15. The Angle of the *Center* of the *Polygon* is P⊙P *Fig.* 73.

16. The *Angle* of the *Polygon* PPP, is always the *Complement* of the Angle at the Center, or remainer unto 180 *Degrees*.

§ 1. 17. The Angle of the *Triangle* PPO is always the one half of the *Angle* of the *Polygon* PPP.

18. The Angle of the *Baſtion*, or the *Flanked* Angle FAF, is expoſed unto the *Batteries* of the *Beſiegers*, and formed by the two *Faces*, FA, and FA, which ought never to be leſs than 60, nor much above 100 *Degrees*. *Fig.* 73.

19. The Angle of the *Eſpaule*, or Shoulder, is formed by the *Face*, and *Flank*, as AFC.

20 The Angle of the *Flank* CCF, is formed by the *Curtain*, and the *Flank*, and is moſt commonly a *Right Angle*, but by ſome later *Inginiers*, is made *Obtuſe*, or more than a *Right Angle*, or 90 *Degrees*.

21. The Angle made by the two lines *Sitchant*, A t A is called the Angle of the *Tenaile*.

22. The Angle forming the *Flank*, is CPF, which Angle is made uſe of by moſt of the *Dutch Inginiers*. *Fig.* 73.

SECT. II.

§. 2. *Of General Maxims or Rules obſerved in Fortifications.*

1. THat all the parts of the Place, be of *Cannon* Proof flanked, *i. e.* defended from another place, which place is no farther diſtant

distant than the reach of a *Musket-ſhoot*, from the place to be *Flanked* or defended *. §. 2.

* *Becauſe the Defence ought to be eaſie, quick, certain, and of little charge, all which qualities the Musket hath and the Cannon hath not, therefore the Defence of Fortification ought to be meaſured by the Port of a Musket, and not by that of a Cannon.*

2. That in all the Place, there may be no part of the *Wall*, or outſide of the *Rampire*, that is not ſeen from the top to the bottome of the *Mote*, or *Ditch*.

3. That the *Baſtions* are large, and full of Earth, and not empty; the bigger they are, they are the more to be eſteemed, there being the more room to intrench, in caſe of neceſſity: whoſe *Gorge* let be at leaſt 35 *fadoms*, and their Flank at leaſt 18 *fadoms*.

4. That the Angle of the *Baſtion*, or *Flanked Angle*, be not much above 90, nor much leſs than 60 Degrees, for in the former it would lie too very *Obtuſe*, and open, at the Point; and in the latter it would be too ſlender, and ſo eaſily to be battered down, by the Enemies *Cannon*.

5. That the Angle of the *Flank* may be ſomewhat *Obtuſe*; neither is there any more virtue in a *Right-angle*, than in any other, for the defence of the *Fort*.

6. That the length of an extended *Curtain* be not above 135 *Fadoms*, nor the ſingle above 80 *Fadoms*, nor be leſs than 40 *Fadoms*, to be well defended from two *Flanks*.

§. 2. 7. That the *Rampire* be ſo wide, that ſo a *Parapet* of Earth *Cannon proof* may be erected thereon, and a *Teraplane* left, full wide for the *Ordnance* to be *recoiled*.

8. That the *Mote* or *Ditch* be at leaſt 20 *Fadoms* broad, and as deep as poſſible. Now dry *Motes* in great Cities are to be preferred before others, that are full of Water, to facilitate the *Sallies*, the relief, and retreat of the *Beſieged*; and in ſmall *Fortifications* the *Motes* full of Water are the moſt Eſteemable, becauſe in ſuch Sallies are not neceſſary, and Surpriſes are very much to be feared.

9 that the Parts that are moſt remote from the *Center*, be commanded by thoſe which are neareſt to it.

10. That the Defence of a *Face* is much ſtronger, when the Angle made by the *Face*, and *Exterior Polygon* is a great Angle; this *Maxim* is ſo very eſſential, that it will try the goodneſs of any *Fortification* whatſoever: Thus I have deſcribed the 10 chiefeſt *Maxims*, neceſſary for good *Fortifications*.

SECT.

SECT. III.

Of the Conſtruction and making of the principal Ground-line of a Fort, according to the moſt Modern ways, uſed by the Italian, Dutch, French, *or* Engliſh Ingineers. §. 3.

I. *Of the* Italian *Fortifications.*

GEnnaro Maria, *Mathematician* to the *Catholick King*, wrote at *Florence*, his *Elements* of *Military Architecture* entituled, *Breve Trattato delle Moderne Fortificazioni.* This *Italian* Author was a very Learned and Skilfull *Mathematician*, and famous in his Nation. In his ſaid Book Printed 1665, he makes the *Interior Polygon* 800, and not leſs than 609 Feet, his *Demi-Gorge*, he makes $\frac{1}{8}$ of it, and ſo for the *Flank* of the *Quadrangle*. But for the *Pentagon*, and all Figures above, he makes the *Flanks* $\frac{1}{10}$ part of the *Gorge* more, and he placeth his *Flank* at *Right Angles* with the *Curtain*.

Suppoſing his *Interior Polygon* 1000 parts, his *Gorges* will be 125, and in the *Quadrangle* the *Flanks* will be 125, but of the *Pentagon*, and all above, 138 parts. For the *Faces*, he makes them to fall on the third part of the *Curtain*, unleſs in the *Square*, which he allows no *ſecond Flank*.

§. 3.

PROP. I.

To fortifie a Hexagon according to this Author's Proportion.

Fig. 74. First describe the *Hexagon* PPP, *&c*, then divide the *Interior Polygon* PP, into 1000 equal parts, take 125 for the *Gorges*, and set it from P to C. Then on C raise a *Perpendicular*, make it equal to 138 parts, for your *Flanks* CF, then draw the *Face* AF, falling on the third part of the *Curtain* CC, at D, and so do on every *Bastion*, untill the work is compleated.

II. *Of the* French *Fortifications.*

Monsieur De la Mont, in his Fortifications *Offensive*, and *Defensive*, printed 1671: And *Monsieur Manesson Mallet* in his late work, intituled *Travaux de Mars*, printed 1672, assigneth these proportions for the laying down the Ground-line of a *Fort*.

Both these Authors make the *Interior Polygon* 768 Englisn Feet, which they divide into 5 parts, and taking one for the *Gorge* 153½ Feet. Both divides it into 3 parts, and takes one for the *Capital*, that is 256 Feet.

Fig. 74. Now our first Author *De la Mont*, makes the *Flank* to stand at *Right-angles* and takes 115½ Feet for it, which is ¼ of the *Curtain*, and so draws the *Bastions*, in all save the *Quadrangle*, and *Pentagon*, which he makes to have no *second Flank*.

PROP.

§. 3.

PROP. II.

To fortifie a Hexagon according to the Proportion of De la Mont.

Firſt deſcribe your *Hexagon* P,P,P, *&c.* Now ſuppoſing your *Interior Polygon* PP, 1000 parts, the *Capital* 333, the *Gorge* 200, and the *Flank* 150 parts, take out of your *Triangular Scale* Fig. 75, (which is made for the more ſpeedy delineation according to this proportion of *De la Mont*) PA for the *Capital*, and prick it off from PA, on all the *Baſtions*. Then take PC, and prick off all the *Gorges* from P to C. Then take FC and prick it off at *Right Angles*, from C to F. Laſtly draw all the *Faces* AF, AF, *&c.* ſo is your *Hexagon* compleat, as required. *Fig.* 74.

PROP. III.

To fortifie a Hexagon according to Maneſſon Mallet's *Proportion.*

Now our Authour *Monſieur Maneſſon Mallet*, in his Works intituled *Travaux de Mars*, deviates from our former Authour, only in this: that as *De la Mont* did place his *Flanks* at *Right Angles*, he places them at 98 *Degrees* with the *Curtains*, and leaves no *ſecond Flank* in all his *Fortifications*.

Therefore having deſcribed the *Polygon* PP, *&c.* divide PP into 1000 parts, prick off the *Capitals* PA 333, and the *Gorges* PC 200, then lay off the *Flanks* CF, 150 parts, at an Angle of *Fig.* 74.

§. 3. of 98 deg. with the Curtain CC (by prop 5. §. 1. chap. 4.) and draw all the *Faces*, AF, AF, *&c.* Falling on C the point of the *Flank* and *Curtain*, ſo ſhall your *Hexagon* be fortified as was required.

III. *Of the* Dutch *Fortifications.*

Fig. 74 The *Emperour Ferdinand* III. hath learnedly altered the Method of *Fritach*, *Dogen*, *Goldman*, and *Faulhaberus*, all which were *Dutch Inginiers*, and wrote large Volumes on this Subject; in his Works intituled *Amuſſis Ferdinandea*, publiſhed 1654; by turning their way of working by Angles, into working by Sides.

Thus he ſetteth down a Catholick way of delineating the Sides, or Lines of any Fort by his 60 prop. thus, the *Interior Polygon* to be 66, the *Capital* 24, the *Gorge* 15, and the *Flank* 12. Or in making the *Interior Polygon* 22, the *Capital* 8, the *Gorge* 5, and the *Flank* 4. Or yet making the *Interior Polygon* 1000, the *Capital* 363, the *Gorge* 227, and the *Flank* 181, this is an *Epitome* of all the *Dutch Fortifications*, and is general excepting for the *Square*, which *Fig.* 74. muſt have no *ſecond Flank.*

PROP. IV.

To fortifie a Hexagon according to the Emperour's Proportion.

Firſt deſcribe the *Polygon* PPP, *&c.* divide P P, *&c.* into 22 parts, take 8 for the *Capitals* PA, which

PA, which prick off all round from P to A, take 5 for the *Gorges*; which prick off all round from C to P, then take 4 for the *Flank* CF, which prick off all round at Right-angles from C to F, laſtly draw the *Faces* AF, AF, AF, *&c.* So is the *Hexagon* compleated as was required. §. 3. *Fig.* 74.

IV. *Of the* Engliſh *Fortifications.*

His late Majeſty of Great Britain Carolus II. of ever bleſſed Memory, hath much facilitated the Method of Count *Pagan*, who in his Fortifications printed at *Paris* 1645, did place the *Flanks* at Right-angles with the *Line of Defence*, and he works by the *Exterior Polygon*. Now His *Majeſty* places the *Flank*, at *Right-angles* with the line of defence of the *Interior Polygon*, and works after another manner: *Count Pagan* makes the proportion of the *Grand Royal Fort*. Suppoſing the *Exterior Polygon* to be 1000 parts, will make the *Perpendicular* MT to be 150, and the *Complement* of the line of *Defence* TC to be 185, which may ſerve for a general proportion be the length what it will, only in a *Square* the proportions muſt thus be altered in the *Grand Royal Fort*, the *Perpendicular* MT muſt be 162, in the *Mean* R 144, and in the *Petty Royal* 126, the *Complement of the Line of Defence* for the *Grand Royal Fort is* 228, and for the *Mean Royal Fort* 198, alſo for the *Petty Royal Fort* 198: *Fig.* 74.

PROP.

§. 3.

PROP. V.

How to fortifie a Hexagon according to Count Pagan's *Proportion.*

To delineate this Work draw a line, about the middle whereof as at M, ſet off MA, the half of the *Exterior Polygon* 500 parts, which makes the *Exterior Polygon* 1000, then on M *Fig.* 74. (by prop. 1. §. 1. chap. 4.) raiſe the *Perpendicular* Mm, which make Mt, MT *Equal* to 150, then draw ATC, and ATC, then take 185, and place it from T to C, and to C, and draw CC for the *Curtain*, then on the points C raiſe *Perpendiculars* CF, to the line of defence CA, for the *Flanks*, ſo have you alſo the *Faces* FA. Then on the Points A ſet off half the Angle of the Figure, to wit 60° (as you ſee in the Table in page 38) and draw the lines OA and O A, ſo ſhall O be the Center of the Figure, and *Fig.* 74. PC the *Gorge*, and AP the *Capitals*: then finiſh each Baſtion at your own diſcretion, and the Work is finiſhed as required.

PROP. VI.

To fortifie a Hexagon according to the way preſcribed by His Majeſty Carolus II.

His late Majeſty *C. II.* hath much facilitated this Work, as will appear in this following Example, by making the line of *Defence*, ſtand at *Right-angles* with the *Flank* of the *Interior Polygon*, by this Table, which ſuppoſes the *Interior Polygon* to be 1000. Then *Fig.* 74.

Polygons

§. 3.

Polygons	4	5	6	7	8	9	10	*Strait-lines.*
Capital	398	437	367	333	312	300	291	233
Gorge-line	155	196	203	242	252	260	263	300

Now deſcribe the *Hexagon* PP, *&c.* Then divide the *Interior Poligon* PP, into 1000 parts, take 367 and prick off all the *Capitals* PA; Then take 203 and prick off all the *Gorges* from P to C. Now draw the *lines of defence* AC and AC, *&c.* Then at C, ſet the *Flanks* at Right Angles with the line of Defence AC, ſo ſhall FC be the *Flank*, and FA the *Faces*, then finiſh every *Baſtion*, and your *Hexagon* is fortified as was required. *Fig.* 74.

☞ Thus have I ſet down the ſeveral Ways and Rules, for laying the fundamental Ground-line, from the moſt conſiderable Inginiers of this laſt Age, out of all which it's moſt agreeable to thoſe Authors, and to practice, to take $\frac{1}{3}$ of the *Interior Polygon* for the *Capital*, $\frac{1}{5}$ for the *Gorge*, and *Flank*, which leaves $\frac{6}{15}$ for the *Curtain*, and let this be taken for a general Rule, where the *Flank*, and *Curtain*, ſtand at *Right Angles*.

Obſerve this for a general Rule in Regular Fortification.

PROP.

§. 3.

PROP. VII.

By the Semicircle to lay down on the Ground, any of the former Fortifications.

Fig. 76. Having drawn the Plot of your *Fort* on Imperial paper, or *Vellom*, and if it be a Regular Fort you need not deſcribe it but two half *Baſtions* from the Center, for that will be ſufficient. Having ſuch a Plate whoſe length is ſet down on each reſpective line, and all proper Angles expreſſed, will not only be uſefull for laying down the Work, but for finding the Solidity of the *Ramparts*, *Parapets*, and the other Earth Works See Fig 76.

Caſe 1. If it be in ſuch a Place, that from the Center of the Fort, all the Angles may be ſeen, place your *Semicircle* at *Z*, and lay off all the Angles of the Center, which here is 60°; then mark out the *Diametrical lines*, and making them their due length, as by your Plate they appear to be, ſet *Piquets*, on all the P, P's upright with the *Plane*, Then take up your Inſtrument and place a *Piquet* at Z. Then lock-ſpit out all the *Polygons* PP. Then mark out the *Gorges* CP,

Fig. 76. then ſet out the *Flanks* CF, either at Right Angles, or as otherwiſe required. Then lock-ſpit out the *Flanks* CF, and the *Faces* AF, having firſt ſet off the *Capital* PA, ſo is the Fort lined out for the *Ground-line*.

Caſe 2. But if there be *Houſes* and *Obſtacles* in the way, that from the Center all may not be ſeen, then muſt you mark out any one ſide and meaſure it, and at each End ſet off the *Angles* of the

the *Polygon*, (which here is 120°) and draw side after side, untill all be finished: Then finish the *Bastions* as before, and here great care must be had, or else you will run into infinite Errours. §. 3.

☞ But you have liberty Experimentally to alter any of the former proportions, as you have occasion, and as will best serve the Place; as you see by the fortifying a streight lined Figure: Fig. 77. wherein *Count Pagan's* or in *Manesson's* way it may not be allowed without some alterations. Fig. 77.

SECT. IV.

Of the Dimensions, and Measures of the Rampires, Parapets, Mote, Coridor, or Covert-way, and its Esplanade, or Breast-work. §. 4.

THE *Rampire's* thickness and height, must receive its Determination from the *Judgment* of the *Inginieri*, and Purse of the *Prince*.

The *Height* TS, must not exceed 18 Feet, nor be less than Ten; the thickness may be from 50, to 80 RA, in all *Royal Works*, and according as Earth is to be had. The slope of the inward side of the *Rampire* TR, is commonly a foot for a foot, therefore RS, the *Talu*, will be equal to the Height TS, so if TS be 18, RS will be 18, if 15 then 15 feet. Fig. 78.

The

§. 3. The outward Slope QA, is generally proportioned ½ a Foot for a Foot, ſo if the Height OQ be 18, the *Talu* OA, will be 9 Feet, *&c.*

Fig. 78. The Height of the *Parapet* ZD, muſt always be 6 Feet, the *Exterior Height* PM muſt be 4 Feet, the thickneſs of the Parapet DQ, in light Earth muſt be 20 Feet, in ſtiff Earth 16, and in Solid Rough Clay 14 Feet; ſuppoſe it be 18 Feet, PM will be 4 Feet, MQ 2 Feet, LD 1 Foot, ſo will the lower thickneſs LQ be 21 Feet.

The Height of the *Banquet* VX is 1½ Foot, and thickneſs VL, 3 Feet.

The *Lizier* muſt be made ſo wide, as to ſupport the *Rampire* from ſlipping into the *Ditch*, and is taken from 3, to 10 Feet; the *Mote* or *Ditch* may be from 70, to 130 Feet broad, that is, from E to G, and the depth IF may be 8, 10, or 12 Foot deep, the little Ditch at the bottom of the *Mote* repreſented by c q g, muſt be as large and deep as the Earth and Work will give leave.

Fig. 78. The *Coridor* and the *Eſplanade* or Breaſt-work on it, is left about 18 Feet wide, from G to C; on which is placed a *Parapet*, and *Banquet*, like that on the *Rampire*, which *Parapet* or *Eſplanade*, muſt ſlope ſo into the *Campaigne*, that a ſtreight line drawn from Z, the Top of the *Rampire*, may terminate OFd, the Slope thereof.

PROP

PROP. VIII. §. 4.

How to lay down the Profile of the Work, according to this Table.

	Feet.	
The Base of the Rampart RA	70	
Height TS *and* QO	16	
Interior Talu RS	16	
Exterior Talu OA	8	
Base of the Parapet LQ	21	
Interior Height ZD	6	
Exterior Height MP	4	
Exterior Talu MQ	2	
Interior Talu QD	1	
Breadth of the Banquet V, L	3	
Height of it V, X	1½	
The Terra Plana TV	25	
The Lizier AE	3	
The Mote's breadth EG	112	*Fig.* 78.
The Depth of it IF	12	
Breadth at its bottom FH	88	
The Talus EI, *or* KG	12	
The Breadth of the little Ditch c g.	18	
The Depth of it	5	
The Coridor GC	18	
The Seat of the Esplanade	60	
The Height CF	6	

Now to lay down this *Profile* draw a line of a convenient length as RSOACGD for the level or Ground-line, then by your Scale of 20, or 30, at most in an Inch, representing Feet. Take out of it 70 for RA, 16 for RS, 8

§. 4. for OA, 3 for AE, 112 for EG, 18 for GC, and 60 for CD, and mark them off on your *Fig.* 78. Paper (as in Fig. 78.) at S, O, I, K, C, raise or let fall *Perpendiculars* (by prop. 1, 2, or 3. §. 1. chap. 4.) then take 16 for ST, and OQ, 12 for I F and K H, and 6 for C f, and draw RT, TQ, QA, EF, HG, c f, f d: Then from Q set off QL 12, LV 3, QM 2, and LD 1, and raise the *Perpendiculars* MP 4, DZ 6, and VX 1½ Then draw VX, XY, YZ, ZP, and PQ, and make the little Ditch by its measure, so is the *Profile* perfected: as for the *Faus-Bray*, they are now put of use, therefore I omit them.

The Solid Content of those Earth-Works may easily be attained by the former Rules which Content being got in Feet, divide that product by 324, the Quotient shall be the *Solid Flores* contained therein, a Flore being 18 Foot square and 1 Foot deep.

SECT. V.

§. 5. *Of the Dimensions and Construction of Platforms, Caveleers and Cazemats in the Flanks.*

1. *Platforms* are Plantations where *Guns* are to be placed, and are commonly made of *Plank*, and *Sleepers*, there needed for one *Gun*, to be but one *Platform*, which must

muſt be 8 Feet broad next the *Parapet*, and 14 Feet wide at the other End, and their length ſhould be 18 Feet. §. 5.

2. An *Embraſure* is the *Port-Hole* made in the *Parapet*, which towards the Gun muſt be 4 Feet wide, and towards the *Campaigne* 8 Feet wide, whoſe height muſt be proportioned unto the Wheel of the Carriage; and are 16, 18 or 20 Feet aſſunder.

3. *Cavaleers* or *Mounts* are Maſſy pieces of Earth raiſed on or near the *Rampart*, above the *Parapet*, on which *Ordnance* and ſmall ſhot may be planted. As to their Conſtruction I ſhall follow the Method of *Maneſſon*, who places them in the *Gorge* of the *Baſtion*, and gives this Rule for it, [ſaith he]. " Lengthen out *Fig.* 79.
" *the line of defence* to E, untill it cut the *Capi-*
" *tal*, the Center of your *Cavaleer* ſhall be the
" middle point betwixt P and E, to wit at F,
" then with the diſtance of 84 Feet on the
" Center F ſtrike a Circle, which ſhall be the
" *Baſe* of your *Cavaleer*: Now its height ought to be at leaſt 20 Feet; and if the Work be to be faced with Stone, or Brick it needs not not have a *Talu* above $3\frac{1}{2}$ Feet, ſo that the *Diameter* at the top will be about $15\frac{3}{4}$ Feet, whereon ſet a *Parapet* of 20 Seat, and high, and other Demenſions as aforeſaid in the *Rampire*, and there will be a *Terra-plana* at the top of above 100 Feet, whereon ſix pieces of *Ordnance* may be planted, making *Embraſures* and *Platforms* as was laſt directed.

4. *Cazemats* are made in the Corners of the *Flanks*, and are ſeveral *Platforms* for *Guns* to be planted on, thereby to be hid from the

§. 4. for OA, 3 for AE, 112 for EG, 18 for GC, and 60 for CD, and mark them off on your
Fig. 78. Paper (as in Fig. 78.) at S, O, I, K, C, raiſe or let fall *Perpendiculars* (by prop. 1, 2, or 3. §. 1. chap. 4.) then take 16 for ST, and OQ, 12 for I F and K H, and 6 for C f, and draw R T, TQ, Q A, EF, HG, c f, f d: Then from Q ſet off Q L 12, LV 3, Q M 2, and LD 1, and raiſe the *Perpendiculars* MP 4, DZ 6, and VX $1\frac{1}{2}$. Then draw VX, XY, YZ, ZP, and PQ, and make the little Ditch by its meaſure, ſo is the *Profile* perfected: as for the *Faus-Bray*, they are now out of uſe, therefore I omit them.

The Solid Content of thoſe Earth-Works, may eaſily be attained by the former Rules, which Content being got in Feet, divide that product by 324, the Quotient ſhall be the *Solid Flores* contained therein, a Flore being 18 Foot ſquare and 1 Foot deep.

SECT. V.

§. 5. *Of the Dimenſions and Conſtruction of Platforms, Caveleers and Cazemats in the Flanks.*

1. *Platforms* are Plantations where *Guns* are to be placed, and are commonly made of *Plank*, and *Sleepers*, there needeth for one *Gun*, to be but one *Platform*, which muſt

muſt be 8 Feet broad next the *Parapet*, and 14 Feet wide at the other End, and their length ſhould be 18 Feet. §. 5.

2. An *Embraſure* is the *Port-Hole* made in the *Parapet*, which towards the Gun muſt be 4 Feet wide, and towards the *Campaigne* 8 Feet wide, whoſe height muſt be proportioned unto the Wheel of the Carriage; and are 16, 18 or 20 Feet aſſunder.

3. *Cavaleers* or *Mounts* are Maſſy pieces of Earth raiſed on or near the *Rampart*, above the *Parapet*, on which *Ordnance* and ſmall ſhot may be planted. As to their Conſtruction I ſhall follow the Method of *Maneſſon*, who places them in the *Gorge* of the *Baſtion*, and gives this Rule for it, [ſaith he]. " Lengthen out *Fig.* 79. " *the line of defence* to E, untill it cut the *Capi-* " *tal*, the Center of your *Cavaleer* ſhall be the " middle point betwixt P and E, to wit at F, " then with the diſtance of 84 Feet on the " Center F ſtrike a Circle, which ſhall be the " *Baſe* of your *Cavaleer*: Now its height ought to be at leaſt 20 Feet; and if the Work be to be faced with Stone, or Brick it needs not but have a *Talu* above 3½ Feet, ſo that the *Diameter* at the top will be about 153 Feet, whereon is a *Parapet* of 20 Seat, and high, and other dimenſions as aforeſaid in the *Rampire*, and there will be a *Terra-plana* at the top of above 80 Feet, whereon ſix pieces of *Ordnance* may be planted, making *Embraſures* and *Platforms* as was laſt directed.

4. *Cazemats* are made in the Corners of the *Flanks*, and are ſeveral *Platforms* for *Guns* to be planted on, thereby to be hid from the

§ 5. Battery of the Enemy: As to the Conſtruction I ſhall follow *Maneſſon*'s Directions, firſt as to the form, and alſo to the meaſure: [ſaith he] "The *Caremate* ſhall take up one half of the "*Flank*, and no more; The *Grand Caremate* D "B is about 7, 8 or 9 Feet from the Level of "the Plane of the Fort, and hath a paſſage into "it from within the Fort A, C is its *Parapet* of 20 "or 22 Foot Seat, and in it let there be 3 or 4 "*Embraſures*; D is the part thereof moſt hid "from the Enemies *Cannon*; F is the *Magazine* *Fig.* 79. "for this *Battery*; H is the ſecond *Caremate*, G "the *Ladder*, and L the *Magazine*, and M the "*Parapet*; this is to hold but one Gun; M is the "third *Caremate* on the level of the *Baſt.* which "let be all firm, in which let there be no void "place. The *Dimenſions* and *Conſtruction* according to the Method of this our Authour are thus [ſaith he] "Lengthen the *Line of Defence* "from C to G ſome 40 Feet, then draw CD, "*parallel* to C f, (by prop. 4. §. 1. chap. 4.) let "CF be half of c f, ſo that c F may be equal to "F f, then from the middle of the *Face* oppoſed, "draw KF, and let it cut GD, in I, then make I *Fig.* 79. "L, and FM equal to 6 Feet, then make MN 66 "Feet, and draw NO *parallel* to the *Flank*, "which let be 24 Feet: Laſtly [ſaith he] for "the *Orillon* or Blind, prolong the Face FT 36 "Feet, and alſo FV 36 Feet, then joyn TV, and "make that part all ſolid: So is your *Caremate* "finiſhed: Let the height of the lower *Caze-* "*mat*, be 6 Feet as before, and let all the reſt "be compleated as you ſee in the Figure.

SECT.

SECT. VI.

Of the Dimenſions, and Conſtructions of thoſe Out-Works, called Ravelins, Horn, Crown-works, &c. §. 6.

THE *Ravelin* is a certain Work lying beyond the *Mote*, or *Ditch*, for the covering the *Curtain*, *Bridge*, and *Gate*; the Angle of the *Ravelin* muſt not be leſs than 60, nor much above 100 deg. the manner of delineating it is thus. Lengthen out the middle line of the *Curtain* OM unto a convenient length, then take with your *Compaſſes* the length of the *Curtain* CC, and ſetting on Foot in F, the point of the *Face* and *Flank*, croſs the middle line in q; then laying your Ruler at q, and to the points F, draw the lines of the *Ravelin* q R and q S, which ſhall be the Ground-lines of the *Ravelin*: The *Mote* ſurrounding it muſt be half the breadth of the *Great Mote*; the *Rampart* may be 30 Feet thick, and ſome 6, 7 or 8 Feet high, on which may ſtand a *Parapet* equal to that of the *Rampire*. *Fig.* 80.

Now if from the points F you raiſe ſtreight lines into the *Campaign*, at *Right Angles* to the *Curtain*, and from the points F ſet off FE, and FE 720 or 750 Feet, then may you joyn EE either with, A; *Fig.* 81.

Single Tenaile: which is done by joyning EE, and dividing it into four equal parts, take one and place from D to N, and ſo draw EN

§. 6. and EN, so have you a *Single Tenail* IENEL, which must have a *Mote Rampire*, and *Parapet* like the *Ravelin*. *Secondly* it may if occasion require be fortified with, A;

Horn-Work: which is done by joyning the points E E, and fortifying the *Exterior Polygon* EE as is afore taught: Or divide EE into three parts; make ME, and EN equal to MO; then draw N M, which divide so likewise at O and P; then draw E O and E P; then at P and O raise *Perpendiculars* O Q and P R, so shall M, E, Q, O, P, R, E, N, be the *Horn-Work* which was desired: which must likewise have small *Rampires* and *Parapets*, as afore.

Fig. 83.

For the *Crown-Work*: From the Center of the Fort O draw O M B of a convenient length, then from the middle of the *Ravelin* set off 1000 or 800 Feet to B, then on q, strike the *Arch* D B E, set off the *Curtain*, and *Demi-Gorge* P C C, from B to F, and G both ways, then draw C F and C E, to terminate the points I and H on the *Counterscarp*; then take $\frac{1}{3}$ part of B F or B E, and set it from B to M; and from F to L, and from E to M; then draw L M, and M N; then for your *Demi-Bastions* make N P and L O equal to N E, *&c.* Then for the *Demi-Gorges* of the whole *Bastion* in the middle, let them be equal to $\frac{1}{5}$ of the *interiour Poligon* L M or M N, *viz.* M Y or M X; then finish the *Bastions* by drawing the lines of *Defence*, and raising *Perpendiculars*, or making *Angles* of 98° at O, X, Y, and P, then the *Crown work* is finished as desired. You may make *Ravelins* and other Works (beforementioned) before these *Curtains* if occasion require.

Fig. 84.

There

There are ſome other Works which are uſed; §. 6.
as *Half Moons*, *Bonnets*, *Double Tenails*, *Countergards*, *Horſeſhoes*, *Prieſts-Caps*, &c. which would be ſuperfluous to ſpeak of in this place.

5. *Cittadels*, are *Caſtles* or *Forts* of the leaſt ſort, and are the Outworks laſtly uſed, which are * commonly of 4 or 5 *Baſtions*, and are placed in ſuch Order, that there may be two *Faces*, and a *Curtain* towards the Town: the Conſtruction whereof is after this manner. Lengthen out the line OM, and therein find the Center of the *Cittadel*, the *Interior Polygon* of the *Pentagon* may be $\frac{3}{4}$ of the *Curtain* adjoyning, or a little more; the Center of the *Square* may be on P the point of the *Interior Polygon*, the Center of the *Hexagon* may be near the outward point of the *Baſtion* of the *Town*, taken away to make the *Cittadel* in, which may be delineated as afore: The *Motes* and other Works in proportion accordingly, and the *Rampires* as high as thoſe of the City or Town.

* *Built to bridle the Town or the Place, leſt the Burghers ſhould be rebellious, and to be the laſt refuge or place of retreat.*

SECT. VII.

§. 7. *Of ſome Maxims or Rules neceſſary to be known in Irregular Fortification.*

Irregular Fortifications is when any Town or Place is to be fortified, which lieth in an Irregular form; *i. e.* whoſe Sides and Angles are unequal in the fortifying of *Irregular Figures**. I ſhall here ſay very little, only I ſhall lay down ſome Precepts that are of immediate concern in fortifying of Irregular Figures, and ſhall refer you to peruſe *Marlois*, *Dogen*, *Fritach*, *Taurnier*, *Dilichius*, &c. which will greatly ſatisfie and help you: To this end know,

* *The Inginier muſt firſt form a Map of the Town or Place, with all the Ways, Paſſages, Old Walls, Rivers, Pools, Encloſures, and all other matters fit to be known in the draught, and then he is to deſign what Works he findeth moſt agreeing to the place to be Fortified.*

1. That the ſame *Laws* and *Maxims* for *Regular Fortifications* ſtand and be in force for *Irregular*; *i. e.* that the line of *Defence* muſt not exceed the *Port* of a *Muſquet*, nor the *Angles* of the *Baſtion* be leſs than 60°, nor much above 90°, *&c.*

2. That no inward Angle of the Place be leſs than 90°, if it be ſo it muſt be altered, and that point may be made the outward point of a *Baſtion*.

3. That

3. That between *Regular* and *Irregular Fortifications*, there is no other difference, but by rectifying the ſides that are too ſhort, or too long, and altering the Angles that are too little; as for the ſides, if they be above 500, and under 1000 Feet, they may be fortified by *Baſtions* placed according to the uſual manner, at the extreme points thereof; But if the ſides be between 1000 and 1700 Feet, then in the midſt you may place a *Plat Baſtion*, and at the *Extreme Points*, place two *Baſtions*, as before: But if the line be leſs than 500 Feet, you may lengthen it, by producing it into the *Plane*: As for the *Angles*, they are made greater or leſſer according as occaſion requireth. For the Raiſing the *Rampires*, *Parapets*, and other Outworks, they are to be as in the *Regular*, and the Out-work may be placed before the *Curtains* as was before mentioned. §. 7.

4. That the *Capital*, in any *Regular* or *Irregular Baſtion*, is found by dividing the *Angle* of the *Polygon* into two equal parts (by prop. 7. §. 1. chap. 4.) and by producing the line of *Angular Diviſion* or *Separation*, on which the due length of the *Capital* muſt be placed, which obſerve for a general Rule.

SECT.

SECT. VIII.

§. 8. *Of the Dimensions and Construction of small Forts, or Sconces, which are built for the Defence of some Pass, River, or other place.*

WHEN they are made Regular, of 4, 5, or 6 *Bastions*, then they may be fortified by the precedent Rules, but there are others of smaller Dimensions fit for the same purpose: *viz. Triangle* with *Demi-Bastions*, *Square* with *Demi-Bastions*, *Parallelograms* with *Demi-Bastions* and *Tong*, *Star Redoubts* of four, five or six points, and *Plain Redoubts*.

PROP. IX.

To fortifie a Triangle, with Demi-Bastions.

This *Triangle* may consist and be comprehended of three equal or unequal sides in this Example: let it be an *Equilaterial Triangle* PPP. Now divide PP into three parts, then take 1, and prick off the *Capitals* PA, *&c.* and the *Gorges* make equal thereunto, as PC, PC, *&c.* then make the *Flanks* FC to stand at *Right Angles*, and to be $\frac{1}{2}$ of PC or PA, then draw the *Faces* AF, AF, *&c.* and the Work is finished as required.

Fig. 84.

PROP.

§. 8.

PROP. X.

To fortifie a Square with Demi-Baſtions.

The ſides of the *Square* may be from 100 to 200 Feet, let PP be 180 Feet, which divide into 3 parts, take one for the *Gorges* PC, and for the *Capitals* PA, and prick them off all round as you ſee, then take ⅛ of PP, and at *Right Angles* prick off the *Flanks* CF, then draw the *Faces* AF, AF, *&c.* and the Figure is compleated. *Fig.* 85.

PROP. XI.

To fortifie a Parallelogram *with Demi-Baſtions, and Tong.*

Firſt deſcribe the *Parallelogram*, or *Long-Square*, PPPP, then divide PP into 6 parts (the ſide on which the *Tong*, or *Tenaile*, is placed) and make MC equal unto ⅛ thereof, and alſo MG, and MH. Draw CG, GC, and CH, HC, then finiſh the *Demi-Baſtions* as before, ſo ſhall the Work be compleated as was required. A *Long Square* may alſo be fortified as Fig. the 77. *Fig.* 86.

PROP. XII.

To fortifie a Star Redoubt of 4, 5, or 6 Points.

1. *A Star Redoubt of four points* may have his ſide from 40 to 60 Feet: Firſt deſcribe the *Square* PPPP, then divide PP into two parts at M, take ¼ of PM, (and by prop. 1. §. 1. ch. 4.) raiſe *Fig.* 87.

§. 8. raiſe *Perpendiculars* round at M, make MA equal to $\frac{1}{4}$ of PM, and draw all as in the Figure.

2. *A Star Redoubt of five points* is thus fortified. Deſcribe the *Pentagon* PP, *&c.* then divide PP into halves at M, raiſe the *Perpendiculars* MA, make MA equal to $\frac{1}{3}$ of PM, and draw the *Fort* *Fig.* 88. in all reſpects as the Figure repreſenteth.

3. *A Star Redoubt of ſix points* is thus fortified. Deſcribe the *Hexagon* PPP, *&c.* divide PP into two equal parts at M, then raiſe *Perpendiculars* at the M's, then make MA equal to $\frac{1}{3}$ of PM, *Fig.* 89. or $\frac{1}{4}$ of PP, and draw every reſpective line as you ſee in the Figure.

PROP. XIII.

To Delineate a Plain Redoubt.

Plain Redoubts are called *Grand Redoubts*, which are uſed as *Batteries* in *Approaches*, whoſe *Fig.* 90. ſide may be from 60 to 80 Feet, or *Petit Redoubt*, which are uſed for a *Court of Guards* in the *Trenches*, and may be from 20 to 50 Feet, and are framed and delineated in all reſpects as you ſee in Fig 90.

The *Profile's* to be ſet on theſe ſeveral Works, and the *Motes*, are alterable and uncertain, for they being ſometimes uſed in *Approaches*; then they do require the *Breaſt-work* at the *Bottom* to be 7 or 8 Foot wide, and the *Interior Height* 6, and the *Exterior* 5 Feet, and the *Mote* to be either 8, 10 or 12 Feet, ſometimes 14 or 20 Feet wide at the bottom, and the height of 7, 8 or 9 Feet, to have two, or three aſcents

aſcents to riſe to the *Parapet*. There are many other things belonging to this Art, which the limitation I am bound to, will not permit here to be treated of. §. 8.

CHAP. XIV.

Of Military Orders, *or the Embattelling and Encamping of Souldiers.*

SECT. I.

Of the Embattelling and Ordering of Souldiers. §. 1.

BATTAILS *are conſidered either in reſpect of the number of Men, or in reſpect of the form of Ground. In the reſpect of the number of Men, it is either a Square Battail, a Double Battail, a Battail of the Grand Front, or a Battail of any proportion, of the number in Rank to the number in File. In reſpect of the form of the Ground, the Battail is either a Geometrical Square of Ground, or a long Square of Ground. For the Diſtance, or Order of Souldiers, martialled*

§. 1. *martialled in Array, is distinguished either into* Open Order, *which is when the Centers of their places are* 7 *Feet distant assunder, both in Rank and File, or* Order; *which is when the Centers of the places are* $3\frac{1}{2}$ *Feet distant both in Rank and File; or else* $3\frac{1}{2}$ *Feet in Rank, and* 7 *Feet in File.*

PROP. I.

To Order any number of Souldiers into a Square Battail of Men.

Admit it were required to Martial into a *Square Battail* 16129 Men: To doe which extract the Square Root of 16129 (by prop. 8. §. 1. chap. 1.) which is 127, therefore you are to place 127 Men in *Rank*, and also in *File*.

PROP. II.

To Order any number of Souldiers into a Double Battail.

Admit 16928 Men were to be Martialled into a *Double Battail*, extract the Root of half the number of Men; *i. e.* of 8464, whose Root is 92, therefore I say that 92 Men must be placed in *File*, and 184 in *Rank*, to order that number of Men propounded into a *Double Battail*.

PROP.

Fig: 73

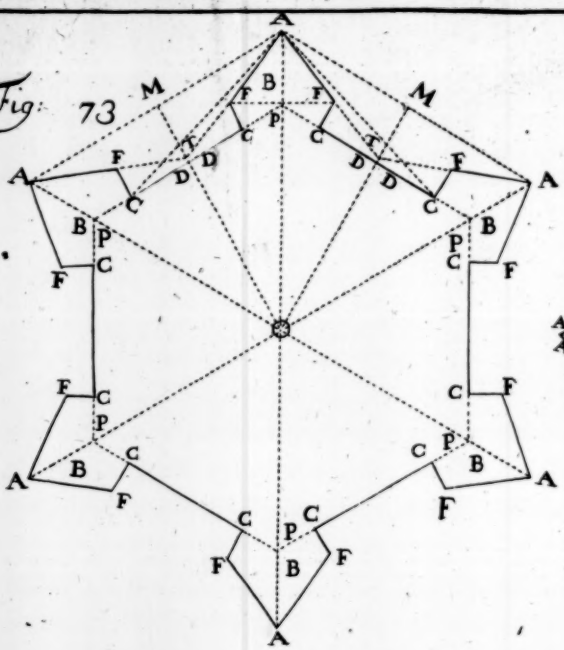


Fig: 74

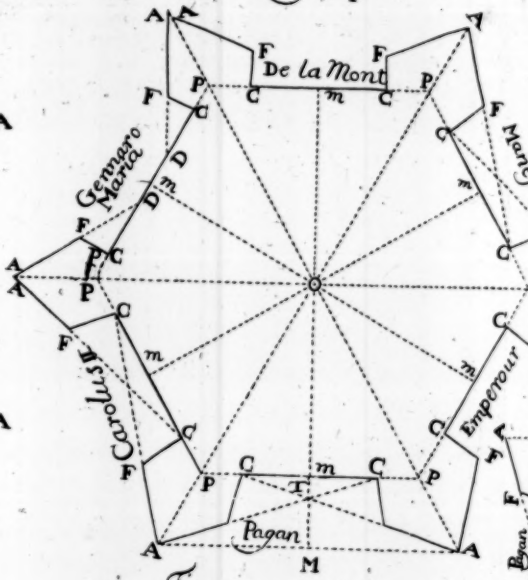


Fig: 75

Fig: 77

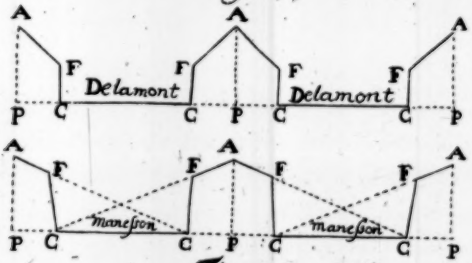


Fig: 77

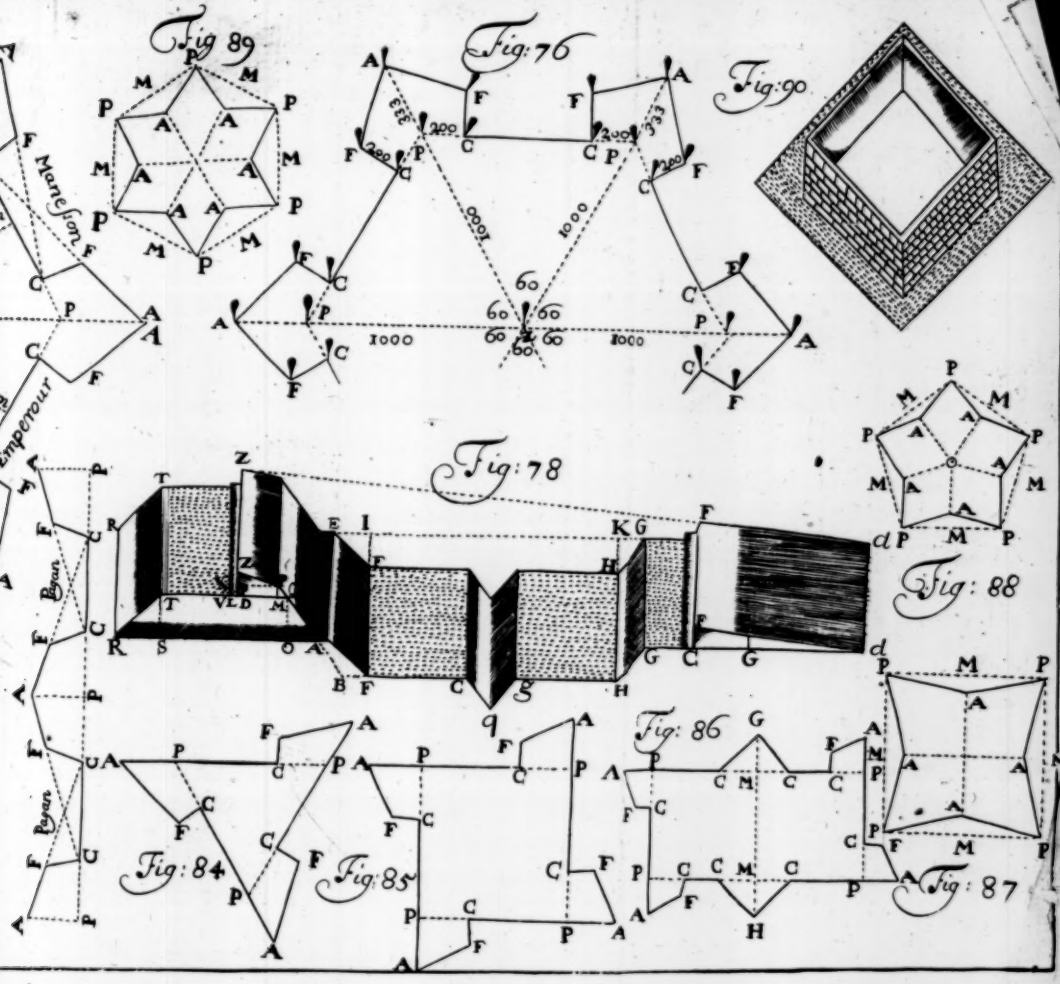


Fig 89
Fig: 76
Fig: 90
Fig: 78
Fig: 88
Fig: 84
Fig: 85
Fig: 86
Fig: 87
Maneson
Pagan
Pagan
1000
1000
1000
1000
200
333
60

C
G
G
F
P
A

§. 1.

PROP. III.

To Order any number of Souldiers into a Battail of the Grand Front.

Admit 16900 *Souldiers* were to be Martialled into a *Battail* of the *Grand Front*, that is *Quadruple*. Extract the Square Root of 4225 (that is $\frac{1}{4}$ of the Men) the Root is 65; therefore I ſay 65 muſt be placed in *File*, and 260 in *Rank*, to form a *Battail* of the *Grand Front*.

PROP. IV.

Any number of Men, together with their diſtance in Rank and File, being propounded, to Order them into a Square Battail of Ground.

Admit 2500 *Souldiers* were to be Martialled into a *Square Battail of Ground*, in ſuch ſort that their diſtance in *File* ſhould be 7 feet, and in *Rank* 3 feet, and 'tis required to know how many Men muſt be placed in *Rank* and in *File* to draw up 2500 Men into *Square Battail* of the *Ground*. According to prop. 1. §. 1. ch. 1. ſay, *As* —— 7 to 3, *So is* 2500 to 1071, &c. whoſe Square Root is 32, &c. Therefore I ſay 32 Men are to be placed in *File*. Now to find how many Men are to be placed in *Rank*, divide 2500 by 32, the Quotient is 78, which are the number of Men to be placed in *Rank*, and 4 Men to be diſpoſed elſewhere.

PROP.

§. 1.

PROP. V.

Any number of Souldiers propounded, to Order them in Rank and File, according to the reason of any two Numbers given.

Admit 6400 *Souldiers* are to be Martialled into *Array*, in such *Order* that the number of Men placed in *File*, shall bear such proportion to the number in *Rank* as 7 to 13; (according to prop. 1. §. 1. chap. 1.) say as 7 to 13, so is 6400 to 11885, &c. whose Square Root is 109, &c. the number of Men to be placed in *Rank*, by which divide 6400, it produces, 58, &c. the number of Men to be placed in *File*, and 78 Men to be employed elsewhere.

SECT. II.

§. 2. *Of Castermetation, or Quartering and Encamping of Souldiers.*

IN Quartering and Encamping of *Souldiers*, it is requisite, the *Quarter-Master General*, and all other under *Quarter-Masters*, be skilled at Foot measure, that so they may lay out their Quarters as directed.

The common allowance for the depth of Ground, that a *Regiment of Horse* or *Foot* will take up, the wideness must be answerable to the

the Number of Men 200 Feet for the *Huts* in length, and 100 for the *Commanders*, and *Sutlers*, before them; every two *Souldiers* to a *Hut*, 8 Feet broad, and 8 Feet deep, 2 Feet *Hut*, from *Hut*, ſo that there may ſtand 20 *Huts* in the 200 Feet, the Ally betwixt *Hut*, and *Hut*, may be 8 Feet, that is 16 Feet in width, and 200 in length for 40 Men, which is 3200 Feet, and for the 100 Feet more, 1600 Feet, in all 4800 Feet, and there muſt be 25 Rows of *Huts*, for 1000 Men; ſo that for a *Regiment of Foot* containing 1000 Men, with *Officers*, and *Sutlers*, will take up 120000 Feet, which is 2 *Acres* and 3 *Roods*, which becauſe of Ways may be allowed 3 *Acres* of Ground; for every *Regiment*, which may be 350 Feet deep, and 370 Feet wide, or near 360 Feet ſquare: Now if 1000 Men, *Officers*, *Sutlers*, *High-ways* and all take up a Square of 360 Feet; how many Feet ſhall the Side of a Square be wherein 10000 *Footmen*, &c. may be encamped? ſay (by prop. 1. chap. 1.) as 1000, to 10000, ſo is the Square of 360, *viz.* 129600, to 1296000, the Square of 1138 Feet, which is very near 30 Acres of Ground. §. 2.

For the Quartering of *Horſe*, you muſt keep the ſame depth of 300 Feet for all, and take 200 Feet for the *Huts*, the *Horſe Huts* muſt be 10 Feet deep, and 4 wide; ſo that 12 *Horſes* may ſtand in one *Hut* together, which is 48 Feet long, and 10 wide, and 6 Feet a Street; The *Huts* for the *Troops*, will be 6, for 12 *Troops*; now conceive a *Regiment* to conſiſt of 8 *Troops*, 50 to a *Troop*, it will take up leaving 20 Feet Streets, and Croſs-ways, very near as much Ground as a *Regiment of Foot*, Ways and all muſt be allowed

§ 2. 3 *Acres*, near 360 *Feet ſquare*, ſo that 10 Regiments of Horſe will take up 30 *Acres*: Moreover, it will be needfull and you may very well allow, as much ground as both *Horſe* and *Foot* will take, for the *Train of Artillery*, *Victuallers*, *Parade* Places, *&c.* From theſe conſiderations the young beginner, nay even the better practiſed Souldier may receive help, and thereby be enabled to Encamp an Army if required.

CHAP. XV.

Of GUNNERY.

SECT. I.

§. 1. *Of the Names of the Principal Members of a Piece of Ordnance.*

1. *Defin.* A CANNON is a long round Body, either of *Braſs*, or *Iron*, formed and made hollow by Art, and proportion, to offend afar off, with a *Ball* of *Iron*, *Stone*, or any Artificial Subſtance, charged with *Gun-Powder*, in its charged *Cilinder*, which being fired, in an inſtant performs its

its desired Effect. This *Machine* was invented by an *Englishman*, and first put in practice by the *Venetians* against the *Genoveses* at *Chiezza*, Anno 1376.

§. 1. *This Military Engine* Bombarda, *Gun, Cannon, &c. So called from* Bombo, *a resounding Noise,* Cannone, *or Cannon, from the likeness it holds with his* Canna, *Bore, or Concavity*; Artigleria, *from* Artiglio, *the Talons, or Claws of Ravenous Fowls, because its shot flying afar off tears and defaces all that it doth meet*; *from whence some Natures of this Machine are called* Smeriglii, *long winged Hawks,* Falconi, *Falconets*; Passa volanti, *swift flying Arrows, &c.*

2. The *Superficies* of the *Mettal*, is the outside round about the *Piece*.

3. The Body is the Substance of the whole Mass of Mettal.

4. The *Chase* is the Concavity of the Piece, in which they put the Charge.

5. the *Muzzel* is the Extremity of the *Chase* by which you load, and unload the Piece.

6. The *Calibre* is AB the *Diameter* of the *Muzzel* or *Mouth*. *Fig.* 91.

7. The *Touch-hole*, is that little *vent*, which passeth from the *Convex Superficies*, to the very *Chamber* of the *Piece*, made to give fire to the *Powder* within as C, that which encloseth the Extremity of the *Chase* about the *Touch-hole* is called the *Breech* or *Coyl*.

8. The *Cascabel* is the *Pammel* at the *Breech* or Coyl as D.

The *Trunnions*, are pieces of Metal fixed unto the *Exterior Superficies* of the *Gun* on which he moves in the *Carriage* as E, E.

§. 1. The *Body* of the *Piece*, is that which is comprehended betwixt the Center of the *Trunnions* *Fig.* 91. and the *Caſcable* EG.

The *Vacant Cylinder*, is comprehended betwixt the Cent. of the *Trunnions* & the *Muzzel* as EB.

The *Frees*, or *Muzzel Ring* is that thick *Corniſh* which incompaſſeth the *Convex Superficies* of the *Piece* at I, The *Baſe Ring* is KLG, *The Reinforced Ring* is M, *The Trunnion Ring is* N, and the *Corniſh Ring is* O.

The *Line of the Cylinder*, is a direct line imagined to be deſcribed along the *Chaſe Parallel* unto the middle of the *Chaſe* as XZ.

Fig. 91. The *Line of Metal*, is a line touching both *Corniſhes*, as MNI.

The *Diſpart line* of the *Piece*, is the difference betwixt the *Semidiameter* of the *Muzzel*, and *Baſe Ring* as the line IH.

The *Vent* of the Piece is the difference betwixt the *Diameter* of the Shot, and the *Mouth* of the *Piece*, as e d.

The *Chamber*, or Charged *Cylinder*, is that part of the *Chaſe* towards the *Touch-hole* equally large, nor narrower in one place than in another, and doth contain the *Powder* and *Ball*.

SECT. II.

§. 2. *Of the Dimenſion of our Uſual Engliſh Cannon, and other Ordnance*, &c.

IN the following Table I have ſet down the length and weight of our moſt uſual Engliſh *Ordnance*, the *Diameters* and Weight of their *Bullets*, the length and breadth of their *Ladles*, the Weight of *Powder* to Charge them, *&c.*

The Names of the Several Pieces of Ordnance.	Guns length Feet	Guns length Inches	Guns weight Pounds	Guns bore Inches	Guns bore 8 parts	Bullets diameter Inches	Bullets diameter 8 parts	Bullets weight Pounds	Bullets weight Ounces	Ladles length Inches	Ladles length 8 parts	Ladles breadth Inches	Ladles breadth 8 parts	Powder weight Pounds	Powder weight Ounces	Shoots Level Paces	Utmost Random Paces
A Base.	4	6	200	1	2	1	1	0	5	4	0	2	0	0	8	60	600
A Rabinet.	5	6	300	1	4	1	3	0	8	4	1	2	4	0	2	70	700
A Falconet.	6	0	400	2	2	1	4	0	12	4	1	2	4	0	4	90	900
A Falcon.	7	0	750	2	6	2	5	0	8	4	2	2	4	0	8	130	1300
Minion ordinary.	7	0	800	3	0	2	7	3	4	4	8	2	5	0	8	120	1200
Minion largest.	8	0	1000	3	2	2	8	0	3	12	9	3	6	0	8	125	1250
Saker least.	8	0	1400	3	4	3	2	4	12	9	6	3	6	4	4	150	1500
Saker ordinary.	9	0	1500	3	6	3	4	6	0	10	4	3	6	4	6	160	1600
Saker old sort.	10	0	1800	4	0	3	6	7	5	11	0	3	7	2	5	163	1630
Demiculver least.	10	0	2000	4	2	4	0	9	0	12	0	3	8	0	6	174	1740
Demiculver ordinary.	11	0	2700	4	4	4	2	10	11	12	6	3	8	0	6	175	1750
Demiculver old sort.	11	0	3000	4	6	4	4	12	11	13	4	3	8	4	8	178	1780
Culverin least.	11	0	4000	5	0	4	6	15	0	14	2	3	9	0	10	180	1800
Culverin ordinary.	12	0	4500	5	2	5	0	17	5	16	0	3	9	4	11	181	1810
Culverin largest.	12	0	4800	5	4	5	2	20	0	16	0	3	10	0	11	183	1830
Demicannon least	11	0	5400	6	2	5	6	0	30	0	20	0	3	11	4	14	0	156	1560
Demicannon ordin.	12	0	5600	6	4	6	1	32	0	22	0	3	12	0	17	8	162	1620
Demicannon large	12	0	6000	6	6	6	3	36	0	22	6	3	12	6	18	0	180	1800
Cannon Royal	12	0	8000	8	0	7	4	58	0	24	0	3	14	0	32	8	185	1850

§. 2.

PROP. I.

How to know the different Fortification of a Piece of Ordnance.

In fortifying any Piece of *Ordnance* there are three degrees observed, as first *Legitimate Pieces*, which are those that are ordinarily fortified; secondly *Bastard Pieces*, which are such whose Fortification is lessened; thirdly *Double fortified Pieces*, or extraordinary *Pieces*.

The Fortification of any Piece of *Ordnance*, is accounted by the thickness of the *Metal* at the *Touch-hole*, *Trunnions*, and at the *Muzzel*, in proportion to the *Diameter* of the *Bore*.

The *Legitimate Pieces*, or the ordinary fortified Cannons, have $\frac{7}{8}$ at the *Touch-hole*, $\frac{5}{8}$ at the *Trunnions*, and $\frac{3}{4}$ at the *Muzzel* of the thickness of the bore, in thickness of Metal. *Bastard Cannons*, or lessned Cannons, have $\frac{3}{4}$ at their *Touch-hole*, or $\frac{12}{16}$, and $\frac{9}{16}$ at their *Trunnions*, and $\frac{5}{8}$ at their *Muzzel*: the *Double fortified Cannons* have full one *Diameter* of the *Bore* in thickness of Metal at the *Touch-hole*, and $\frac{11}{16}$ at the *Trunnions*, and $\frac{7}{16}$ at their *Muzzel*. Now all double fortified *Culverins*, &c. are $1\frac{1}{8}$ at the *Touch-hole*, $\frac{15}{16}$ at the *Trunnions*, and $\frac{9}{16}$ at the *Muzzel*, and the *Ordinary fortified Culverins*, are fortified every way as *double fortified Cannons*, and lessned *Culverins* as *Ordinary Cannons* in all respects.

PROP.

§. 2.

PROP. II.

How to know how much Powder is fit for proof, and what for ſervice, for any Piece of Ordnance.

For *Cannons* take $\frac{1}{3}$ of the weight of their *Iron Bullet* of good Corn Powder for Proof, and for ſervice $\frac{1}{3}$ the weight of the *Iron Bullet* is ſufficient, eſpecially for *Iron Ordnance*, which will not endure ſo much Powder, as *Braſs* ones will receive by $\frac{1}{4}$ in Weight, for *Culverins* allow the whole Weight of the Shoot for Proof, and $\frac{2}{3}$ for Service. For *Sakers*, and *Falcons*, take $\frac{4}{5}$ of the Weight of the Shoot, and for leſſer Pieces the whole weight may be uſed in ſervice, untill they grow hot, but then there muſt be ſome abatement made at diſcretion, and take $1\frac{1}{3}$ of the weight of their *Iron Bullet* for Proof.

PROP. III.

To know what Bullet is fit to be uſed in any Piece of Ordnance.

The *Bullet* muſt be ſomewhat leſs than the Bore of the Gun, that ſo it may have vent in the diſcharge, ſome Authors affirm $\frac{1}{4}$ of an Inch leſs than the Bore will ſerve, all Ordnance, but this vent is too much for a *Falcon*, &c. and too little for a *Cannon*: therefore I approve them not, but commend Mr. *Phillips*'s proportion * to your Uſe, which is to divide the Bore of the Gun into 20 equal parts; and let the *Diameter* of the Bullet be $\frac{19}{20}$ thereof, according to which proportion the precedent Table is calculated.

* *In his Mathematical Manual. page* 165.

§. 2.

PROP. IV.

By knowing the proportion of Metals one to another, and by knowing the Weight of one Ball, to know what any other ſhall weigh.

The common received proportions for *Metals* are theſe.

Lead is to *Iron* as 2, to 3.
Lead is to *Braſs* as 24, to 19.
Lead is to *Stone* as 4, to 1.
Iron is to *Lead* as 3, to 2.
Iron is to *Braſs* as 16, to 18.
Iron is to *Stone* as 3, to 8.

The more exact proportion betwixt Metals are thus known. Admit a *Cube*, or *Ball* of *Gold*, weigh 100 *l.* A Cube of any of thoſe Metals enſuing of the ſame bigneſs, ſhall bear ſuch proportion, as followeth, to the ſaid *Cube* of *Gold*.

	li.	*pts.*		*li.*	*pts.*
Gold.	100	00	*Iron.*	42	10
Quickſilver.	71	43	*Tinn.*	38	95
Lead.	60	53	*Stone.*	15	80
Silver.	54	39	*Water.*	05	68
Braſs.	47	37			

It is the opinion of Dr. *Wybard* in his *Tactometria*, that a Bullet of *Caſt Iron*, whoſe *Diameter* is 4 Inches, doth weigh 9 *l. Averdupoize weight.*

Now to find what any other Bullet, or *Cube* ſhall weigh; ſay (as in prop. 4. chap. 1.) As the *Cube* of the *Bullet* propounded, is to his weight, ſo is the *Cube* of another *Bullet* given, to his weight, and ſo obſerve ſtill this proportion.

SECT.

SECT. III.

Of the Qualification of an able Gunner, and necessary Operations before shooting, and in shooting. §. 3.

A *Gunner* ought to be a Man of Courage, Experience, and Vigilant; he ought to have good skill in *Arithmetick*, to know the Extraction of the *Roots*, &c. He ought to have skill in *Geometry*, to take *heights*, *distances*, &c. to know the Divisions and Use of his *Circle*, *Quadrant*, and *Quadret*; to know how to level, and to lay *Platforms*, and to raise *Batteries*. He must know the Names of all sorts of *Ordnance*, their *Weight*, the *Height* of their *Bore*, the *Height* and *Weight* of their *Shot*, the *length* and *breadth* of their *Ladles*, how much *Powder* to use for *proof*, and *action*; The *Shoots Level*, and the *Shoots Random*; He must know the Names of all the Members of a *Piece of Ordnance*, he must also know the *length*, *thickness* and *breadth* of all manner of *Carriages*, and must know all the parts thereof: *Viz.* the *Cheeks or Sides*, *the Axtree*, *Spokes*, *Nave*, *Hoops*, *Transomes*, *Bolts*, *Plates*, *Drawing-Hooks*, *the Clout*, *the Hole for the Linspin*, *the Shafts*, *the Thill and Thill-bolt*, *the Fore-lock*, *and Fore-lock-keys*, *Capsquares*, *the Fore-lock-pins* and *Chain*, *the Pintle* and *Bolt-hole*, *Fellows*, *Nayles*, *Fellow-bars*, *Stirropes*, the *Ruts* of the *Wheel*, *Dowledges*, *Beds*, *Coines*, *Leveres*, *Hand-screws*, &c. He must also know how to make his *Ladles*, *Spunges*, *Cartridges*,

§. 3. *ges*, whether of *Paper* or *Canvas*, and to have by him *Formeres* of all sorts, *Sheep-skins* undrest to make *Spunges*, *Powder*, *Shot*, *Needles*, *Thread*, *Paste* and *Starch*, *Marlin*, *Twine*, *Nails*, *Hand-spikes*, *Crows* of *Iron*, *Granado-shells*, and Materials for Composition, *Fasces*, *Budg Barrels*, *Cannon-Baskets*, &c. These being general things he is to know, and at all times to have ready by him, and he is more particularly to know these following parts of his Art: As,

PROP. I.

How to Tertiate, Quadrate, and to Dispart a Piece of Ordnance.

1. *To Tertiate a Piece*, is to find whether it hath its due thickness at the *Trunnions*, *Touch-hole*, and *Neck*; if the *Trunnions*, and the *Neck* are in its due order, and the *Chase streight*.

2. *To Quadrate a Piece* mounted, is to see whether it be directly placed, and equally poized in the Carriage; which is known by finding in the *Convex Superficies* of the *Base*, and *Muzzel Ring*; the point which is *Perpendicular*, over the *Soul* of the *Piece*; which may be found by the Gunners Instrument, called a *Level*; an Instrument whose use is so vulgarly known, that it needeth not my Explanation.

3. To *Dispart* a Piece, is to fix, or elevate on the Convex point of the *Muzzel Ring*, a Mark, as far distant from the *Cylinder*, or Soul of the Piece, as is the point of the *Base-Ring*; to the end, that the *Visail-ray* which passeth by these marks, may be *Parallel* to the *Chase*, *Soul*, or *Cy-*

Cylinder of the Piece. Now the *Diſpart*, i. e. §. 3.
the difference of the *Semidiameters* of the *Corniſhes*, may be by a pair of *Calliper Compaſſes* attained. Which found, place on the Top of the *Corniſh-Ring*, near the *Muzzel*, over the middle of the *Inferior Cylinder*.

PROP. II.

To know how far any Piece of Ordnance will ſhoot, &c.

As to the ſeveral ſhootings in *Artillery*, Authors differ much in their Judgments, and Opinions, but they all unanimouſly agree that the *Ball* being ſhot forth flies through the Air, with a *Violent*, *Mixt* and *Natural* motion; deſcribing a *Parabolical line*, in whoſe beginning and ending are lines ſenſibly ſtreight, and in the middle carved: In the beginning the Impreſt *Fig.* 92.
force driving forward by the Fire, the *Natural* gravity of the *Ball* doth deſcribe a *Right-line*, called the *Direct line*, or *Rang* of the *Ball's Circute*.

In the middle that force diminiſheth, and the *Natural Gravity* prevaileth, ſo that it deſcribeth a curved line, called the *Ball's middle Helical* or *Conical Arch*; In the End the *Natural Gravity* overcoming the Impreſt violence, (which becomes altogether weak and faint) deſcribes a new right line, called the *Ball's declining line*, in which the *Ball* tends towards the Center of the Earth, as towards a Place natural unto all heavy bodies: See Figure the 92. Theſe motions are ſomewhat longer, according as the Piece is mounted

* See Mr. Digges *in his* Pantometria, *page* 179.

§. 3. mounted from the level unto the Angle of 45 deg. which is called the *Utmost Random*: The Elevation of which, is regulated by the *Gunners Quadrant*, the Use of which Instrument is so generally known, and by so many Authors fully explained, that I here crave leave to omit it: But take these for General Rules.

General Rules to be observed in the battering down of a Place, or making of Breaches.

1. *That a Shoot at Right Angle, strikes more violent and furiously than at Oblique Angles, therefore Gunners use when they are to batter down a Tower, Wall, or Earth-work, to shoot point blank at the Object, Tire by Tire; by discharging all the Pieces in Battery against the self same Object, in the same Instant,* holding it for a Maxim, *that ten Cannons discharged together, do far more Execution than discharged one after another.* Now at *Oblique Angles* they shoot either Cross-ways or by rebounding.

2. *That the speediest way to make a Breach in a Wall,* &c. *Is by shooting at the Object from two Batteries, which ruins far more speedily than by striking the Object, with one Battery, at Right Angles, although that one Battery, hath as many Cannon as the other* two hath.

3. *That if you were to batter a Flank, covered with an Orillion, (which because you cannot possibly batter it right forward) you must therefore of necessity batter it Obliquely, by way of Rebounding,* thus: Chuse a fit place in the *Curtain* to be your *Object*, on which you may play with your *Battery* obliquely, so that by a rebound the shoot may leap into the *Flanks*, holding for a *Maxim*, in this operation, * *That the Angles of Incidence and Reflection are Equal.*

* According to learned D' Chales, on the 4th Prop. of the first Book of Euclid.

Now we come to shew the length of the

Right

Right Range, of all our Common Engliſh *Ordnance*, which is ſet down in the precedent Table, in which the *Cannon* exceed not 185 *Paces*, *&c.* Eſteeming the Pace 5 Engliſh Feet, nor his *utmoſt Random* above 1850 Paces, which Table ſo ſheweth for all other Natures. §. 3.

As for the *Ranges*, and *Randoms*, to the *ſeveral Degrees* and points of Mounture of the *Quadrant*, I have hereunto annexed the Tables, calculated by the Experiments of ſundry moſt Eminent Artiſts, whoſe Works will perpetuate their Worth and Name to ſucceding Generations.

A Table of Ranges, and Randoms, to the ſeveral Degrees of Mounture of the Quadrent.

A TABLE OF

The Degrees of the Pieces Mounture.	*Right Ranges or Points Blanks.* *The Right Range in Paces of 5 Feet.*	*The Degrees of Mounture.*	*Randoms or the Firſt Graze.* *The Paces of the Random 5 Feet a Pace.*
0	192	0	192
1	209	1	298
2	227	2	404
3	249	3	510
4	261	4	610
5	278	5	722
6	285	6	828
7	302	7	934
8	320	8	1044
9	337	9	1129
10	354	10	1214
20	454	20	1917
30	693	30	2185
40	855	40	2289
50	1000	50	2283
60	1140	60	1792
70	1220	70	1214
80	1300	80	1000
90	1350	90	

§. 3.

The Use of the Table of Randoms.

This Table is most agreeing to *Cannons*, and *Culverins*, and the greatest sort of *Ordnance*, the Use thereof is thus.

Admit a *Saker* to be mounted to 3 deg. shoots the Bullet 323 *Paces*, how far will it shoot being mounted unto 7 *deg.* Say (*by prop.* 1. *chap.* 1.)

As 510 the Tabular distance for 3 deg. of Mounture, to 323, the distance found,

So is 934 the Tabular distance for 7 deg. of Mounture, to $591\frac{272}{510}$, the distance required, which the *Saker* according to this Experiment shall shoot at 7 deg. of Mounture.

Mr. *NYE* in his Book of Gunnery printed *Anno*, 1647, saith he made an Experiment by a *Saker* of 8 Feet long, which he loaded with three pounds of *Powder*, of an exact weight, both *Powder* and *Wad* at every charge, every time ramming it down with three equal stroaks, as near as possible; but on the *Bullet* he put no *Wad*, because the *Saker* was mounted; And thus he made four Shoots, each of them half an Hour after the other, that so the Piece might be of equal temper, and mounted his Piece to these 4 degrees of Mounture, *viz.* 1 deg. 5 deg. 7 deg. 10 deg. and found these Randoms.

At 1 *Deg. the Random* was 225
At 5 *Deg. the Random* was 416
At 7 *Deg. the Random* was 505
At 10 *Deg. the Random* was 630
} *Paces.*

Accor-

According to which Experiment, he framed this Table of *Randoms*. §. 3.

Deg.	*Paces*	*Deg.*	*Paces*
0	206	6	461
1	225	7	505
2	274	8	548
3	323	9	589
4	370	10	630
5	416		

Captain HEXAM in his Book of *Gunnery*, ſhews how by finding out the *Random* of a *Cannon*, for the firſt Degree of Mounture, thereby to find the *Random* for every Degree to 45 deg. or utmoſt Random, and this is his Rule to perform it. Firſt find how many Paces the *Cannon* will ſhoot being laid level by the Metal, (which by him is accounted 1 deg.) Then divide the diſtance found, by 50, then multiply the Quotient by 11, ſo ſhall the product be the greateſt *Digreſſion*, or *Difference* betwixt *Rangs*, and *Rang*; which being divided by 44, the Quotient giveth the Number of *Paces*, which the *Bullet* will *loſe* in the other *Rangs*, from *Degree*, unto *Degree*; according to this Rule, this Table is calculated.

A Table

§. 3.

A Table of Randoms to 45 Degrees, accounting a Pace 2 ½ Foot.

D. Moun	Paces.	Diff.	D. Moun.	Paces.	Diff.
0	0775	225	23	4685	110
1	1000	220	24	4795	105
2	1220	215	25	4900	100
3	1435	210	26	5000	95
4	1645	205	27	5095	90
5	1850	200	28	5185	85
6	2050	195	29	5270	80
7	2245	190	30	5350	75
8	2435	185	31	5425	70
9	2620	180	32	5595	65
10	2800	175	33	5560	60
11	2975	170	34	5620	55
12	3145	165	35	5675	50
13	3310	160	36	5725	45
14	3470	155	37	5770	40
15	3625	150	38	5810	35
16	3775	145	39	5845	30
17	3920	140	40	5875	25
18	4060	135	41	5900	20
19	4595	130	42	5920	15
20	4325	125	43	5935	10
21	4450	120	44	5945	5
22	4570	115	45	5950	

I have

I have hereunto also annexed the Table calculated by *Alexander Bianco*, for all sort of Ordnance, (which Table I account one of the best that was ever yet found Extant) In his Work printed 1648. §. 4.

A Table of Randoms for the first six Points of the Gunner's Quadrant.

Points.	1	2	3	4	5	6
Falconet.	375	637	795	885	892	900
Falcon.	550	935	1166	1254	1309	1320
Minion.	450	765	954	1026	1071	1080
Saker.	625	1062	1325	1125	1487	1500
Demi-culver.	725	1232	1537	1653	1725	1740
Culverin.	750	1275	1590	1710	1785	1800
Demi-cannon.	625	1062	1325	1425	1487	1500
Cannon of 7.	675	1147	1431	1489	1606	1620
Double Cannon.	750	1275	1590	1710	1785	1800

SECT. IV.

Of Shooting in Mortar-Pieces. §. 4.

A *Mortar-Piece* is a short Piece, with which they shoot *Bombs*, *Granado-Shells*, *Stone-Balls*, &c. not by a Right line but from a Curved, from on high; so that it may fall where it

§. 4. ſhould be deſired: Now this *Mortar* is placed in the *Carriage*, in all reſpects as you ſee in Fig. *Fig.* 93. 93. in which A ſignifies the *Carriage*, B the *Mortar*, C the *Courſe the ſhoot flies*, and D the *Place* on which it falls.

Bombs are great hollow Balls of *Iron*, or *Braſs*, in which are put fine *Sifted Gun-Powder*, which by a *Fuſe*, they proportion to them a due Fire, that ſo they may break aſſoon as they fall amongſt the Enemies. Theſe *Fuſes* are ſmall Trunks of *Wood*, *Tinn*, or *Iron*, filled with a *prepared Compoſition* for that purpoſe. *Granadoes* are of the ſame form with *Bombs*, only ſmaller, and many times are caſt by hand, and are made of *Iron*, *Braſs*, *Glaſs*, or *Earth*.

Now in Order to the well ſhooting in thoſe kind of *Machines* called *Mortars*, 'tis requiſite to obſerve theſe following Rules: as,

1. *That before you make a ſhoot at any Place, you find the diſtance thereof from your Mortar, which may be obtained by Prop.* 3. §. 4. *Chap.* 9.

2. *That the Bombs, or other Bodies that are to be ſhot, be of equal weight, otherwiſe the ſhoots will vary.*

3. *That the Carriage in breadth be always on a Level, and without any deſcent, that ſo it may not leap in diſcharging.*

4. *That the Powder with which the Mortar is loaded, be always of the ſame force and weight.*

5. *That the Charge of the Mortar, as well in Powder as in Wadding, be always rammed in with blows equally heavy, and of equal number.*

6. *That the Wadds be always either of Wood, or Tampeons, or elſe of Okam, for the ſtrongeſt drives it fartheſt.*

7. *That*

7. *That the Fuſes be newly made, in thoſe days that they are to be uſed, and that they be made of a Compoſition proportionable to the Range that the ſhoot ſhall make in the Air, ſo that the Bomb may break in the very moment of its fall; which Compoſition muſt be ſuch, that though it fall in the Water, yet not to extinguiſh, but the Bomb there to break.* Now before we proceed any farther, I think it neceſſary, to ſhew how to compoſe your Ingredients for your *Fuſe*. §. 4

PROP. I.

To make Fuſes for Bombs, &c.

The Compoſition for *Bombs* muſt be of a ſlow motion, that ſo time enough may be given to throw either *Bombs*, *Granadoes*, *Fire-balls*, *Thundring-Barrels*, &c. They are compounded of theſe Ingredients, thus: Take a pound of *Gun-Powder*, $\frac{4}{16}$ of *Sulphur*, $\frac{4}{16}$ of *Salt-Peter*, well beaten, dry, and ſifted ſeparately, then mix it, and make up your *Fuſe* thereof: Or take Powder of *Benjamin*, and *Small-Coles*, all well beaten and mixed together with ſome *Oyl of Piter*, and ſo fill your *Fuſe* therewith.

Now the uſe of *Mortar-Pieces*, being for the moſt part to ſhoot up at *Random*, therefore the *Randoms* of theſe Pieces is very neceſſary to be known: Therefore hereunto I have annexed the Tables of *Randoms*, calculated by the Experience of the beſt of Authors, which have wrote on this Subject; moſt of which do agree in their *Randoms*, although they are in a ſeveral dreſs.

§. 4. *Diego-Uffano-Zutphen* in his Works printed 1621, hath calculated theſe two following Tables, the one for the 12 points of the *Quadrant*, the other for every *Degree*, taking the one Half of each Number, and ſo 'tis reduced into our Engliſh Paces of 5 Feet, which Tables were eſteemed and made uſe of, both by Captain *Hexam*, and Mr. *Norton*, and are as followeth.

A Table of Randoms for Mortar-Pieces, to the 12 Points of the Gunner's Quadrant, calculated by Diego-Uffano-Zutphen.

583	570	534	468	377	248	100	
6	5	4	3	2	1	0	
•	•	•	•	•	•	•	⊙
6	7	8	9	10	11	12	
583	570	534	468	377	248	000	

Now ſuppoſe the *Mortar* to be placed at ⊙, the Pricks in the middle line repreſenteth the ſeveral *Randoms*, numbred with the Degrees of the *Quadrant*, forward and backward, unto which the ſeveral Randoms are ſet; ſo you ſee that the *Mortar* being levelled point blank, throweth the *Bomb* 100 *Paces*, if the *Mortar* be mounted one Point, it throws the *Bomb* 248 Paces, *&c.* untill 'tis mounted to the 6*th.* point, 583 *Paces*,

583 *Paces*, which is the utmoſt Random: Now if the *Mortar* be mounted higher to 7, 8, 9, *&c.* Points, the *Randoms* decreaſe again as before they did increaſe: as you ſee in the *Table.* §. 4

But in thoſe latter *Randoms* there lieth a great miſtake, as ſhall be made palpably appear. For if as they are diſtant from the ſixth Point you make them equal to one another, then the Random of the 12 points, muſt be equal to the Random of 0 point, or the *Level Random*, which is 100 Paces from the Mortar. Now it is contrary to all Art and Reaſon, to think that if the *Mortar* be elevated to the 12*th.* point, *i.e.* bolt upright, it ſhould ſhoot the Bomb 100 Paces from the *Mortar*; no, it cannot be; but according to all Reaſon the *Bomb* muſt fall down either on, or near the *Mortar*, and not 100 Paces diſtant, as is moſt erroneouſly conceived; the like errour is in the following Table of our ſaid Author; but becauſe Mr. *Phillipps* in his *Mathematical Manual* hath amply demonſtrated their Errours, I therefore ſhall ſay no more to the Errours that have been a long time generally conceived and embraced as a truth, but now are removed.

A Table

§. 4

A Table of Randoms for Mortar-Pieces, to every Degree of the Quadrant.

The Degrees of Mounture.	The Paces of the Random.	The Degrees of Mounture.	The Degrees of Mounture.	The Paces of the Random.	The Degrees of Mounture.
0	100	89	23	480	66
1	122	88	24	490	65
2	143	87	25	500	64
3	164	86	26	510	63
4	185	85	27	518	62
5	204	84	28	525	61
6	224	83	29	531	60
7	243	82	30	536	59
8	263	81	31	540	58
9	280	80	32	543	57
10	297	79	33	549	56
11	315	78	34	552	55
12	331	77	35	558	54
13	347	76	36	562	53
14	362	75	37	568	52
15	377	74	38	573	51
16	393	73	39	577	50
17	406	72	40	580	49
18	419	71	41	581	48
19	432	70	42	582	47
20	445	69	43	583	46
21	457	68	44	584	
22	460	67	45	585	

The moſt exact Tables of Randoms for the *Mortar*, that I have ſeen or can find in any Ancient, or Modern Author, is this following Table, calculated by the experience and trial of that Famous Inginier *Tomaſo Moretii* of *Breſcia*, Inginier to the moſt ſerene *Republique of Venice*, in his Works Intituled, *Trattatu delle Artiglieria*, printed 1665. Where he ſuppoſeth the utmoſt

Random

Random, equal to 10000, according to which proportion he framed this following Table. §. 4.

A Table of the ſeveral Randoms of each Degree of the Quadrant, the greateſt Equal to 10000.

Elev.		*Elev.*	*Elev.*		*Elev.*
1°	349	89°	23°	7193	67°
2	698	88	24	7431	66
3	1045	87	25	7660	65
4	1392	86	26	7880	64
5	1736	85	27	8090	63
6	2079	84	28	8290	62
7	2419	83	29	8480	61
8	2756	82	30	8660	60
9	3090	81	31	8829	59
10	3420	80	32	8988	58
11	3746	79	33	9135	57
12	4067	78	34	9272	56
13	4384	77	35	9397	55
14	4695	76	36	9511	54
15	5000	75	37	9613	53
16	5299	74	38	9703	52
17	5592	73	39	9781	51
18	5870	72	40	9848	50
19	6157	71	41	9903	49
20	6428	70	42	9945	48
21	6691	69	43	9976	47
22	6947	68	44	9994	46
			45	10000	45

The Uſe of the Precedent Table is explained by theſe following Propoſitions.

PROP. II.

Finding that a Mortar of 300, *with a Tampeon of Wood, being elevated* 45°, *or* 6 *Points of the Quadrant, ſends a Bomb* 800 *Paces, how many Paces ſhall the ſame ſhoot, at the Elevation of* 54°?

Look at the ſaid 54° of the Table, and you will *Demonſtration.*

§. 4. will find the proportional Number 9511, to correſpond thereunto. Now you find the proportional Number belonging to 45° is 10000, then by *Prop.* 1. *Chap.* 1. Say as 10000, to 800, ſo is 9511, to $760\frac{88}{100}$, which are the *Paces*, the *Mortar* will ſend the *Bomb* at the *Elevation of* 54 *Degrees.*

PROP. III.

Finding that a Mortar of 300, *being elevated* 54°, *ſends his Bomb* $760\frac{88}{100}$ *Paces, what Degree of Elevation muſt that Mortar have, to ſhoot the Bomb* 555 *Paces?*

This is but the Converſe of the former, therefore (according to *Prop.* 1. *Chap.* 1.) ſay, as $760\frac{88}{100}$ *Paces*, gives the proportional part or number 9511; ſo doth 555 *Paces*, give the proportional part 6945. Which number ſought among the proportional Numbers, in the Table, you will find 68 *Degrees* to correſpond to that proportional Number 6945, ſo that the *Mortar* muſt be elevated to 68 *Degrees* to ſhoot the *Bomb* 555 *Paces*, which was required to be known. Theſe Rules and Precepts here delivered, I eſteem neceſſary to be known by every *Gunner*, who intends to be ſerviceable for his *Prince* and *Countrey.*

Vive, vale: Siquid noviſti rectius iſtis,
Candidus imperti: Si non his utere mecum.

Hora. *lib.* 1. *Epiſt.*

FINIS.

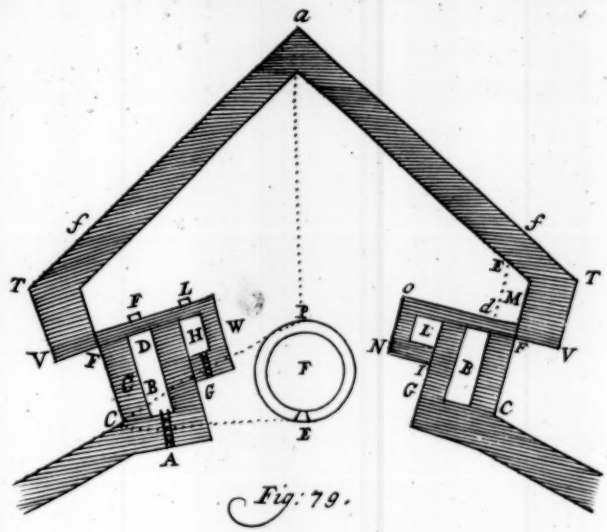
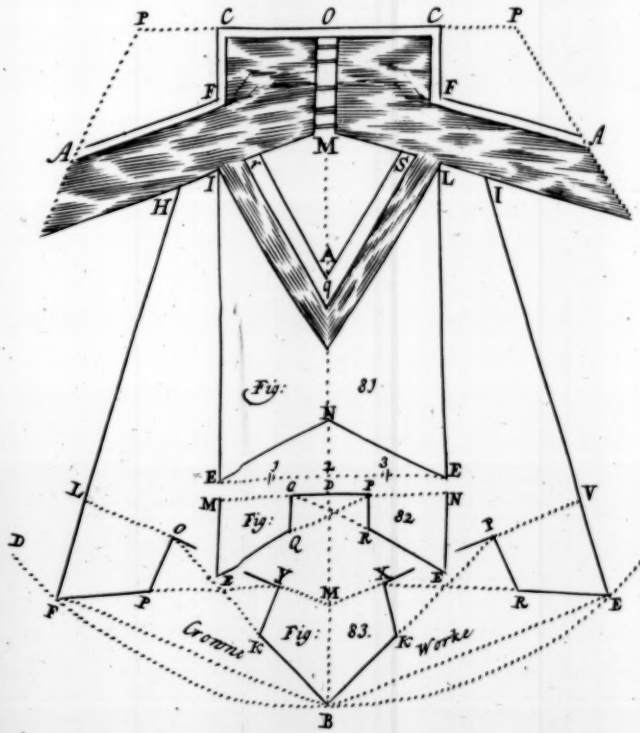


Fig: 79.

Figure 80.



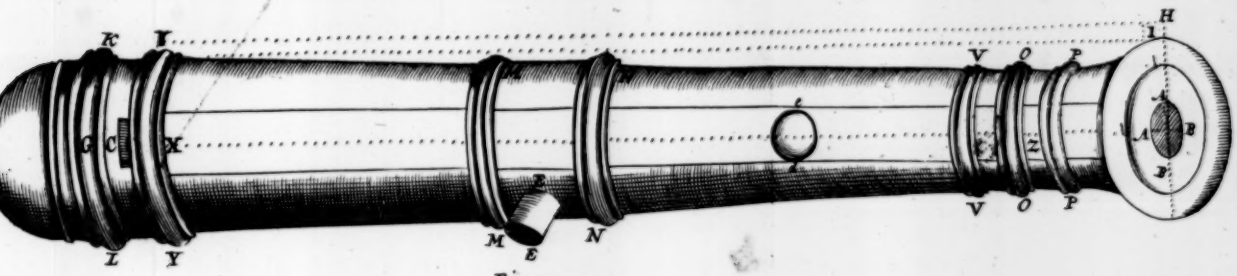


Figure 91

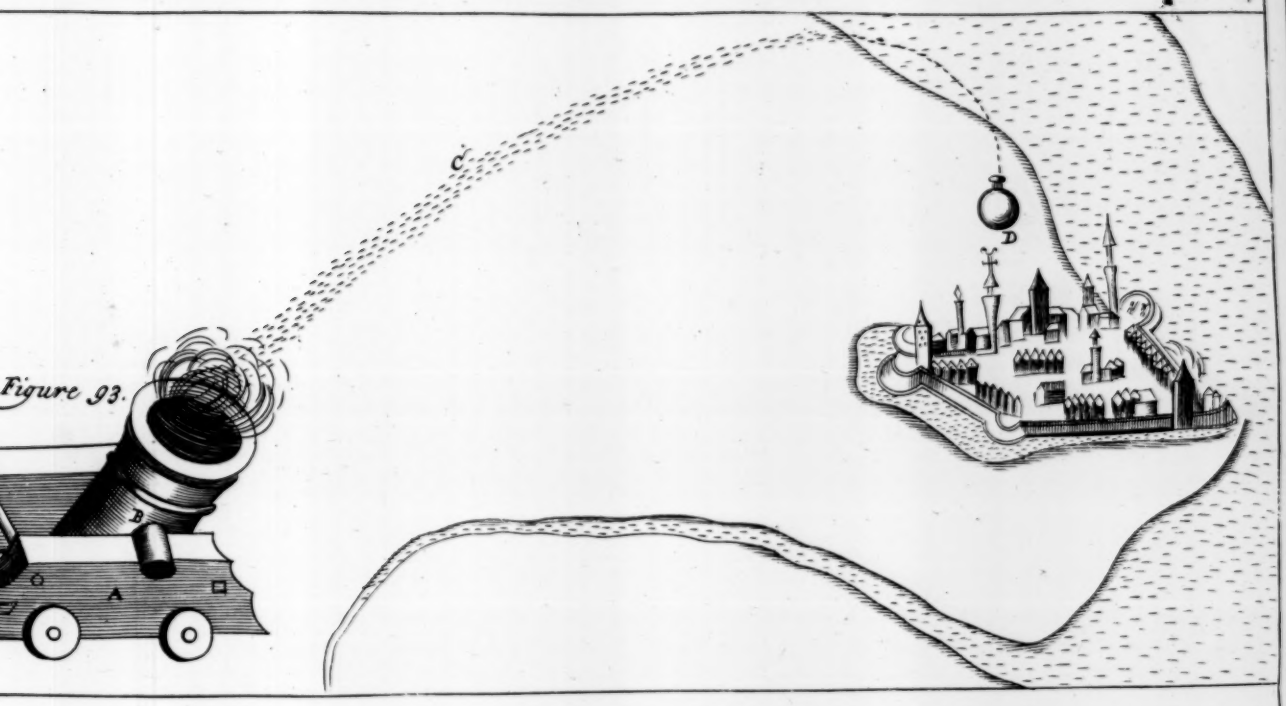
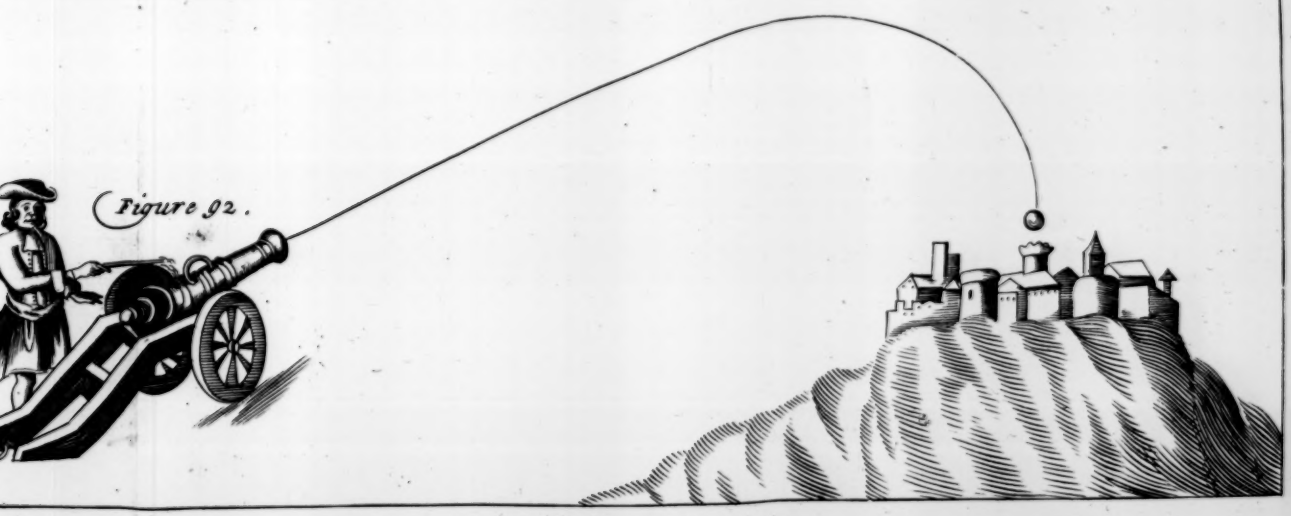


Figure 93.

Figure 92.



A

TABLE

OF

Logarithm Numbers,

From One to Ten Thouſand:

Whereby the

LOGARITHM

OF ANY

NUMBER

Under Four Hundred Thouſand may be readily diſcovered.

LONDON,

Printed by *J. Heptinſtall* for *W. Freeman*, at the *Artichoke* next St. *Dunſtan's* Church in *Fleetſtreet*. MDCLXXXVII.

N	Log.	N	Log.	N	Log.
1	0. 000000	34	1.531479	67	1. 826075
2	0. 301030	35	1.544068	68	1. 832509
3	0. 477121	36	1.556303	69	1. 838849
4	0. 602060	37	1.568202	70	1. 845098
5	0. 698970	38	1.579783	71	1. 851258
6	0. 778151	39	1.591064	72	1. 857332
7	0. 845098	40	1.602060	73	1. 863323
8	0. 903090	41	1.612784	74	1. 869232
9	0. 954242	42	1.623249	75	1. 875061
10	1. 000000	43	1.633468	76	1. 880813
11	1. 041393	44	1.643452	77	1. 886491
12	1. 079181	45	1.653212	78	1. 892094
13	1. 113943	46	1.662758	79	1. 897627
14	1. 146128	47	1.672098	80	1. 903090
15	1. 176091	48	1.681241	81	1. 908485
16	1. 204120	49	1.690196	82	1. 913814
17	1. 230449	50	1 698970	83	1. 919078
18	1. 255272	51	1.707570	84	1. 924279
19	1. 278753	52	1.716003	85	1. 929419
20	1. 301030	53	1.724276	86	1. 934498
21	1. 322219	54	1.732394	87	1. 939519
22	1. 342422	55	1.740362	88	1. 944482
23	1. 361728	56	1.748188	89	1. 949390
24	1. 380211	57	1.755875	90	1. 954242
25	1. 397940	58	1.763428	91	1. 959041
26	1. 414973	59	1.770852	92	1. 963788
27	1. 431364	60	1.778151	93	1. 968483
28	1. 447158	61	1.785330	94	1. 973128
29	1. 462398	62	1.792391	95	1. 977723
30	1. 477121	63	1.799340	96	1. 982271
31	1. 491361	64	1.806180	97	1. 986772
32	1. 505150	65	1.812913	98	1 991226
33	1. 518514	66	1 819544	99	1. 995635

N	0	1	2	3	4
100	000000	000434	000868	001301	001734
101	004321	004751	005181	005609	006038
102	008600	009026	009451	009876	010299
103	012837	013259	013679	014100	014521
104	017033	017451	017898	018284	018700
105	021189	021603	022016	022428	022841
106	025306	025715	026125	026533	026942
107	029384	029789	030195	030599	031004
108	033424	033826	034227	034628	035029
109	037426	037825	038223	038620	039017
110	041393	041787	042182	042576	042969
111	045323	045714	046105	046495	046885
112	049218	049603	049993	050379	050766
113	053078	053463	053846	054229	054613
114	056905	057286	057666	058046	058426
115	060698	061075	061452	061829	062206
116	064458	064832	065206	065579	065953
117	068186	068557	068928	069298	069668
118	071882	072249	072617	072985	073352
119	075547	075912	076276	076640	077004
120	079181	079543	079904	080266	080626
121	082785	083144	083503	083861	084219
122	086359	086716	087071	087426	087781
123	089905	090258	090610	090963	091315
124	093422	093772	094122	094471	094820
125	096910	097257	097604	097951	098298
126	100371	100715	101059	101403	101747
127	103804	104146	104487	104828	105169
128	107209	107549	107888	108227	108565
129	100589	100926	111263	111599	111934

5	6	7	8	9	D
002166	002598	003029	003461	003891	432
006466	006894	007321	007748	008174	428
010724	011147	011570	011993	012415	424
014940	015359	015779	016197	016616	416
019116	019532	019947	020361	020775	416
023252	023664	024075	024486	024895	412
027349	027757	028164	028571	028978	408
031408	031812	032216	032619	033021	404
035429	035829	036229	036629	037028	400
039414	039811	040207	040602	040998	396
043362	043755	044148	044539	044932	393
047275	047664	048053	048442	048830	389
051153	051538	05 924	052309	052694	386
054996	055378	055760	056142	056524	382
058805	059185	059563	059942	060320	379
062582	062958	063333	063709	064083	376
066326	066699	067071	067443	067815	372
070038	070407	070776	071145	071514	369
073718	074085	074451	074816	075182	366
077368	077731	078094	078457	078819	363
08c987	081347	081707	082067	082426	360
084576	084934	085291	085647	086004	357
088136	088490	088845	089198	089552	355
091667	092018	092369	092721	093071	351
095169	095518	095866	096215	096562	349
098644	098989	099335	099681	100026	346
102091	102434	102777	103119	103462	343
105510	105851	106191	106531	106871	340
108903	109241	109579	109916	110253	338
112269	112605	112939	113275	113609	335

N	0	1	2	3	4
130	113943	114277	114611	114944	115278
131	117271	117603	117934	118265	118595
132	120574	120903	121231	121559	121888
133	123852	124178	124504	124830	125156
134	127105	127429	127753	128076	128399
135	130334	130655	130977	131298	131619
136	133539	133838	134177	134496	134814
137	136721	137037	137354	137671	137987
138	139879	140194	140508	140822	141136
139	143015	143327	143639	143951	144263
140	146128	146438	146748	147058	147367
141	149219	149527	149835	150142	150449
142	152288	152594	152899	153205	153509
143	155336	155639	155943	156246	156549
144	158362	158664	158965	159266	159567
145	161368	161667	161967	162266	162564
146	164353	164650	164947	165244	165541
147	167317	167613	167908	168203	168497
148	170262	170555	170848	171141	171434
149	173186	173478	173769	174059	174351
150	176091	176381	176669	176959	177248
151	178977	179264	179552	179839	180126
152	181844	182129	182415	182699	182985
153	184691	184975	185259	185542	185825
154	187521	187803	188084	188316	188647
155	190332	190612	190892	191171	191451
156	193125	193403	193681	193959	194237
157	195899	196176	196453	196729	197005
158	198657	198932	199206	199481	199755
159	201397	201670	201943	202216	202488

5	6	7	8	9	D
115611	115943	116276	116608	116939	333
118926	119256	119586	119915	120245	330
122216	122544	122871	123198	123525	328
125481	125806	126131	126456	126781	325
128722	129045	129368	129689	130012	323
131939	132259	132579	132899	133219	321
135133	135451	135769	136086	136403	318
138303	138618	138934	139249	139564	315
141449	141763	142076	142389	142702	314
144574	144885	145196	145507	145818	311
147676	147985	148294	148603	148911	309
150756	151063	151369	151676	151982	307
153815	154119	154423	154728	155032	305
156852	157154	157457	157759	158061	303
159868	160168	160469	160769	161068	301
162863	163161	163459	163758	164055	299
165838	166134	166430	166726	167022	297
168792	169086	169380	169674	169968	295
171726	172019	172311	172603	172895	293
174641	174932	175222	175512	175802	291
177536	177825	178113	178401	178689	289
180413	180699	180986	181272	181558	287
183269	183555	183839	184123	184407	285
186108	186391	186674	186956	187239	283
188928	189209	189490	189771	190051	281
191730	192009	192289	192567	192846	279
194514	194792	195069	195346	195623	278
197281	197556	197832	198107	198382	276
200029	200303	200577	200850	201124	274
202761	203033	203303	203577	203848	272

N	0	1	2	3	4
160	204119	204391	204663	204934	205204
161	206826	207096	207365	207364	207904
162	209515	209783	210051	210319	210586
163	212187	212454	212720	212986	213252
164	214844	215109	215373	215638	215902
165	217484	217747	218010	218273	218536
166	220108	220369	220631	220892	221153
167	222716	222676	223236	223496	223755
168	225309	225568	225827	226084	226342
169	227887	228142	228400	228657	228913
170	230449	230704	230959	231215	231469
171	232996	233250	233504	233752	234011
172	235528	235781	236033	236285	236537
173	238046	238297	238548	238799	239049
174	240549	240799	241048	241297	241546
175	243038	243286	243534	243782	244029
176	245513	245759	246006	246252	246499
177	247973	248219	248464	248709	248954
178	250420	250664	250908	251151	251395
179	252853	253096	253334	253580	253822
180	255273	255514	255755	255996	256237
181	257679	257918	258158	258398	258637
182	260071	260309	260548	260787	261025
183	262451	262688	262925	263162	263399
184	264818	265054	265289	265525	265761
185	267172	267406	267641	267875	268109
186	269513	269746	269979	270213	270446
187	271842	272074	272306	272538	272769
188	274158	274389	274619	274850	275081
189	276462	276692	296921	277151	277379

5	6	7	8	9	D
205475	205746	206016	206286	206556	271
208173	208441	208710	208978	209247	269
210853	211121	211388	211654	211921	267
213518	213783	214049	214314	214579	266
216166	216429	216694	216957	217221	264
218798	219060	219323	219585	219846	262
221414	221675	221936	222196	222456	261
224015	224274	224533	224791	225051	259
226599	226858	227115	221372	227629	258
229169	229426	229682	229938	230193	256
231724	231979	232234	232488	232742	254
234264	234517	234770	235023	235276	253
236789	237041	237292	237544	237795	252
239299	239549	239799	240049	240299	250
241795	242044	242293	242541	242789	249
244177	244525	244772	245019	245266	248
246745	246991	247237	247482	247728	246
245198	249443	249687	249932	250176	245
251638	251881	252125	252368	252610	243
254064	254306	254548	254789	255031	242
256477	256718	256958	257198	257438	241
258877	259116	250355	259594	259833	239
261263	261501	261739	261976	262214	238
263636	263873	264109	264346	264582	237
265996	266232	266467	266702	266937	235
268344	268578	268812	269046	269279	234
270679	270912	271144	271377	271609	233
273001	273233	273464	273696	273927	232
275311	275542	275772	276002	276232	230
277609	277838	278067	278296	278525	229

N	0	1	2	3	4
190	278754	278982	279211	279439	276667
191	281033	281261	281488	281714	281942
192	283301	283527	283753	283979	284205
193	285557	285782	286007	286232	286456
194	287802	288026	288249	288473	288696
195	290035	290257	290479	290702	290925
196	292256	292478	292699	292920	293141
197	294466	294687	294907	295127	295347
198	296665	296884	297104	297323	297542
199	298853	299071	299289	299507	299725
200	301030	301247	301464	301681	301898
201	303196	303412	303628	303844	304059
202	305351	305566	305781	305996	306211
203	307496	307709	307924	308137	308351
204	309630	309843	310056	310268	310481
205	311754	311966	312177	312389	312600
206	313867	314078	314289	314499	314709
207	315970	316180	316389	316599	316809
208	318063	318272	318481	318689	318898
209	320146	320354	320562	320769	320977
210	322219	322426	322633	323839	323046
211	324282	324488	324694	324899	325105
212	326336	326541	326745	326949	327155
213	328379	328583	328787	328991	329194
214	330414	330617	330819	331022	331225
215	332438	332640	332842	333044	333246
216	334454	334655	334856	335057	335257
217	336459	336659	336859	337059	337259
218	338456	338656	338856	339054	339253
219	340444	340642	340841	341039	341237

5	6	7	8	9	D
279895	280123	280351	280578	280806	228
282169	282396	282622	282849	283075	227
284431	284656	284882	285107	285332	226
286681	286905	287129	287354	287578	225
288919	289143	289366	289589	289812	223
291147	291369	291591	291813	292034	222
293362	293584	293804	294025	294246	221
295567	295787	296007	296226	296446	220
297761	297979	298198	298416	298635	219
299943	300161	300378	300595	300813	218
302114	302331	302547	302764	302979	217
304275	304491	304706	304921	305136	216
306425	306639	306854	307068	307282	215
308564	308778	308991	309204	309417	213
310693	310906	311118	311329	311542	212
312812	313023	313234	313445	313656	211
314920	315130	315340	315551	315760	210
317018	317227	317436	317646	317854	209
319106	319314	319522	319730	319938	208
321184	321391	321598	321805	322012	207
323252	323458	323665	323871	324077	206
325310	325516	325721	325926	326131	205
327359	327563	327767	327972	328176	204
329398	329601	329805	330008	330211	203
331427	331629	331832	332034	332236	202
333447	333649	333859	334051	334253	202
335458	335658	335859	336059	336259	201
337459	337659	337859	338058	338257	200
339453	339650	339849	340047	340246	199
341435	341632	341830	342028	342225	198

N	0	1	2	3	4
220	342227	342620	342817	343014	343212
221	344392	344589	344785	344981	345178
222	346353	346549	346744	346939	347135
223	348305	348499	348694	348889	349083
224	350248	350442	350636	350829	351023
225	352183	352375	352568	352761	352954
226	354108	354301	354493	354685	354876
227	356026	356217	356408	356599	356790
228	357935	358125	358316	358506	358696
229	359835	360025	360215	360404	360593
230	361728	361917	362105	362294	362482
231	363612	363799	363988	364176	364363
232	365488	365675	365862	366049	366236
233	367356	367542	367729	367915	368101
234	369216	369401	369587	369772	369958
235	371068	371253	371437	371622	371806
236	372912	373096	37327 9	373464	373647
237	374748	374932	375115	375298	375481
238	376577	376159	376942	377124	377306
239	378398	378579	378761	378943	379124
240	380211	380392	380573	380754	380934
241	382017	382197	382377	382557	382737
242	383815	383995	384174	384353	384533
243	385606	385785	385964	386142	386321
244	387389	387568	387746	387923	388101
245	389166	389343	389520	389698	389875
246	390935	391112	391288	391464	391641
247	392697	392873	393048	393224	393399
248	394452	394627	394802	394977	395152
249	396199	396374	396548	396722	396896

5	6	7	8	9	D
343409	343606	343802	343999	344196	197
345373	345569	345766	345962	346157	196
347330	347525	347720	347915	348110	195
349278	349472	349659	349860	350054	194
351216	351409	351603	351796	351989	193
353147	353339	353532	353724	353916	193
355068	355239	355452	345643	355834	192
356981	357172	357363	357554	357744	191
258886	359076	359266	359456	359646	190
360783	360972	361161	361350	361539	189
362671	362859	363048	363236	363424	188
364551	364739	364926	365113	365301	188
366423	366609	366796	366983	367169	187
368287	368473	368659	368845	369030	186
370143	370328	370513	370698	370882	185
371991	372175	372359	372544	372728	184
373831	374015	374198	374382	374565	184
375664	375846	376029	376212	376394	183
377488	377670	377852	378034	378216	182
379306	379487	379668	379849	380030	181
381115	381296	381476	381656	381837	181
382917	383097	383277	383456	383636	180
384712	384891	385069	385249	385428	179
389499	386677	386856	387034	387212	178
388279	388456	388634	388811	388989	178
390051	390228	390405	390582	390759	177
391817	391993	392169	392345	392521	176
393575	393751	393926	394101	394277	176
395326	395501	395676	395850	396025	175
397071	397245	397419	397592	397766	174

N	0	1	2	3	4
220	342227	342620	342817	343014	343212
221	344392	344589	344785	344981	345178
222	346353	346549	346744	346939	347135
223	348305	348499	348694	348889	349083
224	350248	350442	350636	350829	351023
225	352183	352375	352568	352761	352954
226	354108	354301	354493	354685	354876
227	356026	356217	356408	356599	356790
228	357935	358125	358316	358506	358696
229	359835	360025	360215	360404	360593
230	361728	361917	362105	362294	362482
231	363612	363799	363988	364176	364363
232	365488	365675	365862	366049	366236
233	367356	367542	367729	367915	368101
234	369216	369401	369587	369772	369958
235	371068	371253	371437	371622	371806
236	372912	373096	373279	373464	373647
237	374748	374932	375115	375298	375481
238	376577	376159	376942	377124	377306
239	378398	378579	378761	378943	379124
240	380211	380392	380573	380754	380934
241	382017	382197	382377	382557	382737
242	383815	383995	384174	384353	384533
243	385606	385785	385964	386142	386321
244	387389	387568	387746	387923	388101
245	389166	389343	389520	389698	389875
246	390935	391112	391288	391464	391641
247	392697	392873	393048	393224	393399
248	394452	394627	394802	394977	395152
249	396199	396374	396548	396722	396896

5	6	7	8	9	D
343409	343606	343802	343999	344196	197
345373	345569	345766	345962	346157	196
347330	347525	347720	347915	348110	195
349278	349472	349659	349860	350054	194
351216	351409	351603	351796	351989	193
353147	353339	353532	353724	353916	193
355068	355239	355452	345643	355834	192
356981	357172	357363	357554	357744	191
258886	359076	359266	359456	359646	190
360783	360972	361161	361350	361539	189
362671	362859	363048	363236	363424	188
364551	364739	364926	365113	365301	188
366423	366609	366796	366983	367169	187
368287	368473	368659	368845	369030	186
370143	370328	370513	370698	370882	185
371991	372175	372359	372544	372728	184
373831	374015	374198	374382	374565	184
375664	375846	376029	376212	376394	183
377488	377670	377852	378034	378216	182
379306	379487	379668	379849	380030	181
381115	381296	381476	381656	381837	181
382917	383097	383277	383456	383636	180
384712	384891	385069	385249	385428	179
389499	386677	386856	387034	387212	178
388279	388456	388634	388811	388989	178
390051	390228	390405	390582	390759	177
391817	391993	392169	392345	392521	176
393575	393751	393926	394101	394277	176
395326	395501	395676	395850	396025	175
397071	397245	397419	397592	397766	174

N	0	1	2	3	4
250	397940	398114	398287	398461	398634
251	399674	399847	400019	400192	400365
252	401401	401573	401745	401917	402089
253	403121	403292	403464	403635	403807
254	404834	405005	405176	405346	405517
255	406540	406710	406881	407051	407221
256	408239	408409	408579	408749	408918
257	409933	410102	410271	410439	410609
258	411619	411788	411956	412124	412293
259	413299	413467	413635	413803	413969
260	414973	415140	415307	415474	415641
261	416641	416807	416973	417139	417306
262	418301	418467	418633	418798	418964
263	419956	420121	420289	420451	420616
264	421604	421768	421933	422097	422261
265	423246	423409	423574	423737	423901
266	424882	425045	425208	425371	425534
267	426511	426674	426836	426999	427161
268	428135	428297	428459	428621	428783
269	429752	429914	430075	430235	430398
270	431369	431525	431685	431846	432007
271	432969	433129	433289	433449	433609
272	434569	434729	434888	435048	435207
273	436163	436322	436481	436639	436799
274	437751	437909	438067	438226	438384
275	439333	439491	439648	439806	439964
276	440909	441066	441224	441381	441538
277	442479	442637	442793	442949	443106
278	444045	444201	444357	444513	444669
279	445604	445759	445915	446071	446226

5	6	7	8	9	D
398808	398981	399154	399328	399501	173
400538	400711	400883	401056	401228	173
402261	402433	402605	402777	402949	172
403978	404149	404320	404492	404663	171
405688	405858	406029	406199	406369	171
407391	407561	407731	407901	408070	170
409087	409257	409426	409595	409764	169
410777	410946	411114	411283	411451	169
412461	412629	412796	412964	413132	168
414137	413405	414472	414639	414806	167
415808	415974	416141	416308	416474	167
417472	417638	417804	417969	418135	166
419129	419295	419460	419625	419791	165
420781	420945	421110	421275	421439	165
422426	422589	422754	422918	423082	164
424065	424228	424392	424555	424718	164
425697	425860	426023	426186	426349	163
427324	427486	427648	427811	427973	162
428944	429106	429268	429429	429591	162
430559	430719	430881	431042	431203	161
432167	432328	432488	432649	432809	161
433769	433929	434089	434249	434409	160
435366	435526	435685	435844	436004	159
436957	437116	437275	437433	437592	159
438542	438701	438859	439175	439165	158
440122	440279	440437	440594	440752	158
441695	441852	442009	442166	442323	157
443263	443419	443576	443732	443889	157
444825	444981	445137	445293	445449	156
446382	446537	446692	446848	447003	155

N.	0	1	2	3	4
280	447158	447313	447468	447623	447778
281	448706	448861	449015	449169	449324
282	452049	450403	450557	450711	450865
283	451786	451939	452093	452247	452399
284	453318	453471	453624	453777	453929
285	454845	454997	455149	455302	455454
286	456366	456518	456669	456821	456973
287	457889	458033	458184	458336	458487
288	459392	459543	459694	459845	459995
289	460898	461048	461198	461348	461499
290	462398	462548	462647	462847	462997
291	463893	464042	464191	464340	464489
292	465383	465532	465680	465829	465977
293	466868	467016	467164	467312	467460
294	468347	468495	468643	468790	468938
295	469822	469969	470116	470263	470410
296	471292	471438	471585	471732	471878
297	472756	472903	473049	473195	473341
298	474216	474362	474508	474653	474799
299	475671	475816	475962	476107	476252
300	477121	477266	477411	477555	477699
301	478566	478711	478855	478999	479143
302	480007	480151	480294	480438	480582
303	481443	481586	481729	481872	482016
304	482874	483016	483159	483302	483445
305	484299	484442	484585	484727	484869
306	485721	485863	486005	486147	486289
307	487138	487279	487421	487563	487704
308	488551	488692	488833	488974	489114
309	489958	490099	490239	490379	490520

5	6	7	8	9	D
447932	448088	448242	448397	448552	155
449478	449633	449787	459941	450095	154
451018	451172	451326	451479	451633	154
452553	452706	452859	453012	453165	153
454082	454235	454387	454539	454692	153
455606	455758	455910	456062	456214	152
457125	457276	457428	457579	457731	152
458638	458789	458939	459091	459242	151
460146	460296	460447	460597	460748	151
461649	461799	461948	462098	462248	150
463146	463296	463445	463594	463744	150
464639	464788	464936	465085	465234	149
466126	466274	466423	466571	466719	149
467608	467756	467904	468052	468199	148
969085	469233	469380	469527	469675	147
470557	470704	470851	470998	471145	147
472025	472171	472318	472464	472610	146
473487	473633	473779	473925	474071	146
474944	475089	475235	475381	475526	145
476397	476542	476687	479832	476976	145
477844	477989	478133	478278	478422	145
479287	479431	479575	479719	479863	144
480725	480869	481012	481156	481299	144
482159	482302	482445	482588	482731	143
483587	483729	483872	484015	484157	143
485011	485153	485295	485437	485579	142
486430	486572	486714	486855	486997	142
487845	487986	488127	488269	488409	141
489255	489396	489537	489677	489818	141
490661	490801	490941	491081	491222	140

N	0	1	2	3	4
310	491362	491502	491642	491782	491922
311	492760	492900	493039	493179	493319
312	494155	494294	494433	494572	494711
313	495544	495683	495822	495960	496099
314	496929	497068	497206	497344	497483
315	498311	498448	498586	498724	498862
316	499687	499824	499962	500099	500236
317	501059	501196	501333	501470	501607
318	502427	502564	502700	502837	502973
319	503791	503927	504063	504199	504335
320	505149	505286	505421	505557	505193
321	506505	506640	506776	506911	507046
322	507856	507991	508126	508260	508395
323	509203	509337	509471	509606	509740
324	510545	510679	510813	510947	511081
325	511883	512017	512151	512284	512418
326	513218	513351	513485	513617	513750
327	514548	514681	514813	514946	515079
328	515874	516006	516139	516271	516403
329	517196	517328	517459	517592	517724
330	518514	518646	518777	518909	519040
331	519828	519959	520090	520221	520353
332	521138	521269	521399	521530	521661
333	522454	522575	522705	522835	522966
334	523746	523876	524006	524136	524266
335	520545	525174	525304	525434	525563
336	526339	526469	526598	526727	526856
337	527629	527759	527888	528016	528145
338	528916	529045	529174	529302	529430
339	530199	530328	530456	530584	530712

5	6	7	8	9	D
492062	492201	492341	492481	492621	140
493458	493597	493737	493876	494015	139
494850	494989	495128	495267	495406	139
496238	496376	496515	496653	496791	139
497921	497759	497897	498035	498173	138
498999	495137	499275	499412	499549	138
500374	500510	500648	500785	500922	137
501744	501880	502017	502154	502291	137
503109	503246	503382	503518	503655	136
504471	504607	504743	504878	505014	136
505828	505964	506099	506234	506369	136
507181	507316	507451	507586	507721	135
508529	508664	508799	508934	509068	135
509894	510009	510143	510277	510411	134
511215	511349	511482	511616	511749	134
512551	512684	512818	512951	513084	133
513883	514016	514149	514282	514415	133
515211	515344	515476	515609	515741	133
516535	516668	516796	516932	517064	132
517855	517987	518119	518251	518382	132
519171	519303	519434	519566	519697	131
520484	520615	520745	520876	521007	131
521792	521922	522053	522183	522314	131
523096	523226	523356	523486	523616	130
524396	524526	524656	524785	424915	130
525693	525822	525951	526081	526210	129
526985	527114	527243	527372	527501	129
528274	528402	528531	528659	528788	129
525559	529687	529815	529943	530072	128
530839	530968	531096	531223	531351	128

N	0	1	2	3	4
340	531479	531607	531734	531862	531989
341	532754	532882	533009	533136	533264
342	534026	534153	534280	534407	534534
343	535294	535421	535547	535674	535800
344	536558	536685	536811	536937	537063
345	537819	537945	538071	538197	538322
346	539076	539202	539327	539452	539578
347	540329	540455	540579	540705	540829
348	541579	541704	541829	541953	542078
349	542825	542949	543074	543199	543323
350	545008	544192	544316	544440	544564
351	545307	545431	545555	545678	545802
352	546543	546666	546789	546913	547036
353	547775	547898	548021	548144	548267
354	549003	549126	549249	549371	549494
355	550228	550351	550473	550595	550717
356	551449	551572	551694	551816	551938
357	552668	552789	552911	553033	553155
358	553883	554004	554126	554457	554368
359	555094	555215	555336	554247	555578
360	556303	556423	556544	556664	556785
361	557057	557627	557748	557868	557988
362	558709	558829	558948	559068	559188
363	559907	560026	560146	560265	560385
364	561101	561221	561339	561459	561578
365	562293	562412	562531	562649	562769
366	563481	563599	563718	563836	563955
367	564666	564784	564903	565021	565139
368	565848	565966	566084	566202	566319
369	567026	567144	567262	567379	567497

5	6	7	8	9	D
532117	532245	532372	532499	532627	128
533391	533518	533645	533772	533899	127
534661	534787	534914	535041	535167	127
535927	536053	536179	536304	536432	126
537189	537315	537441	537567	537693	126
538448	538574	538699	538825	538951	126
539703	539829	539954	540079	540204	125
540955	541079	541205	541329	541454	125
542203	542327	542452	542576	542701	125
543447	543571	543696	543819	543944	124
544688	544812	544934	545059	545183	124
545925	546049	546172	546296	546419	124
547159	547282	547405	547529	547652	123
548389	548512	548635	548758	548881	123
549616	549739	549861	549984	550106	123
550839	550962	551084	551206	551328	122
552059	552181	552303	552425	552547	122
553276	553398	553519	553640	553762	121
554489	554610	554731	554852	554973	121
555699	555819	555940	556061	556182	121
556905	557026	557146	557267	557387	120
558108	558228	558349	558469	558589	120
559308	559428	559548	559667	559787	120
560504	560624	560743	560863	560982	119
561698	561817	561936	562055	562174	119
562887	563006	563125	563244	563362	119
564074	564192	564311	564429	564548	119
565257	565376	565494	565612	565729	118
566437	566555	566673	566791	566909	118
567614	567732	567849	567967	568084	118

N	0	1	2	3	4
370	568202	568319	568436	568554	568671
371	569374	569491	569608	569725	569842
372	570543	570659	570776	570893	571009
373	571709	571825	571942	572058	572274
374	572872	572988	573104	573219	573336
375	574031	574147	574263	574379	574494
376	575188	575303	575419	575534	575649
377	576341	576457	576572	576687	576802
378	577492	577607	577722	577836	577951
379	578639	578754	578868	578983	579097
380	579784	579898	580012	580126	580241
381	580925	581039	581153	581267	581381
382	582063	582177	582291	582404	582518
383	583199	583312	583426	583539	583652
384	584331	584444	584587	584670	584783
385	585461	585574	585686	585799	585912
386	586587	586699	586812	586925	587037
387	587712	587823	587935	588047	588159
388	588832	588944	589056	589167	589279
389	589949	599061	590173	590284	590396
390	591065	591176	591287	591399	591509
391	592177	592288	592399	592509	592621
392	593286	593397	593508	593618	593729
393	594393	594503	594614	594724	594834
394	595496	595606	595717	595827	595937
395	596597	596707	596817	596927	597037
396	597695	597805	597914	598024	598134
397	598790	598899	599009	599119	599228
398	599883	599992	600101	600210	600319
399	690073	601082	601191	601299	601408

5	6	7	8	9	D
568788	568905	569023	596139	569257	117
569959	570076	570193	570309	570426	117
571126	571243	571359	571476	571592	117
572291	572407	572523	572639	572755	116
573452	573568	573684	573799	573915	116
574609	574726	574841	574957	575072	116
575765	575880	575996	576111	576226	115
576917	577032	577147	577262	577377	115
578066	578181	578295	578409	578525	115
579212	579326	579441	579555	579669	114
580355	580469	580583	580697	580811	114
581495	581608	581722	581836	581949	114
582631	582745	582858	582972	583085	114
583765	583879	583992	584105	584218	113
584896	585009	585122	585235	585348	113
586024	586137	586249	586362	586475	113
587149	587262	587374	587486	587599	112
588272	588384	588496	588608	588719	112
589391	589503	589615	589726	589838	112
590507	590619	590730	590842	590953	112
591621	591732	591843	591955	592066	111
592732	592843	592954	593064	593175	111
593839	593950	594061	594171	594282	111
594945	595055	595165	595276	595386	110
596047	596157	596267	596377	596487	110
597146	597256	597366	597476	597586	110
598243	598353	598462	598572	598681	110
599337	599446	599556	599665	599774	109
600428	600537	600646	600755	600864	109
601517	601625	601734	601843	601951	109

N	0	1	2	3	4
400	602059	602169	602277	602386	602494
401	603144	603253	603361	603469	603577
402	604226	604334	604442	604550	604658
403	605305	605413	605521	605628	605736
404	606381	606489	606596	606704	606811
405	607455	607562	607669	607777	607884
406	608526	608633	608739	608847	608954
407	609594	609701	609808	609914	610021
408	610660	610767	610873	610979	611086
409	611723	611829	611936	612042	612148
410	612784	612889	612996	613102	613207
411	613842	613947	614053	614159	614264
412	614897	615003	615108	615213	615319
413	615950	616055	616160	616265	616370
414	617000	617105	617210	617315	617419
415	618048	618153	618257	618362	618466
416	619093	619198	619302	619406	619511
417	620136	620240	620344	620448	620552
418	621176	621280	621384	621448	621592
419	622214	622318	622421	622525	622628
420	623249	623353	623456	623559	623663
421	624282	624385	624488	625591	624695
422	625312	625415	625518	625621	625724
423	626340	626443	626546	626648	626751
424	627366	627468	627571	627673	627775
425	628389	628491	628593	628695	628797
426	629409	629512	629613	629715	629817
427	630428	630529	630631	630733	630835
428	631444	631545	631647	631746	631849
429	632457	632559	632659	632761	632862

5	6	7	8	9	D
602603	602817	602819	602928	603036	108
603686	603794	603902	604009	604118	108
604766	604874	604982	605089	605197	108
605844	605951	606059	606166	606274	108
606919	607026	607133	607241	607348	107
607991	608098	608205	608312	608419	107
609061	609167	609274	609381	609488	107
610128	610234	610341	610447	610555	107
611192	611298	611405	611511	611617	106
612254	612359	612466	612572	612678	106
613313	613419	613525	613630	613736	106
614369	614475	614581	614686	614792	106
615424	615529	615634	615739	615845	105
616476	616581	616686	616790	616895	105
617523	617629	617734	617839	617943	105
616571	618676	618780	618889	618989	105
619615	619719	619824	619928	620032	104
620656	620760	620864	620968	621072	104
621695	621799	621902	622007	622110	104
622722	622835	622939	623042	623146	104
623766	623869	623973	624076	624179	103
624798	624901	625004	625107	625209	103
625827	625929	626032	626135	626237	103
626853	626956	627058	627161	627263	103
627878	627979	628082	628185	628287	102
628899	629002	629104	629206	629308	102
629919	620021	630123	630224	630326	102
630936	631038	631139	631241	631342	102
631951	632051	632153	632255	632356	101
632963	633064	633165	633266	633367	101

N	0	1	2	3	4
430	633468	633569	633670	633771	633872
431	634477	634578	634679	634779	634880
432	635484	635584	635685	635785	635886
433	636488	636588	636688	636789	636889
434	637489	637589	637689	637789	637889
435	638489	638589	638689	638789	638888
436	639486	639586	639686	639785	639885
437	640481	640581	640680	640779	640879
438	641475	641573	641672	641771	641871
439	642465	642563	642662	642761	642860
440	643453	643551	643650	643749	643847
441	644439	644537	644636	644734	644833
442	645422	645521	645619	645717	645815
443	646404	646502	646599	646698	646796
444	647383	647481	647579	647676	647774
445	648360	648458	648555	648653	648750
446	649335	649432	649529	649627	649724
447	650308	650405	650502	650599	650696
448	651278	651375	651472	651569	651666
449	652246	652343	652439	652536	652633
450	653213	653309	653405	653502	653598
451	654177	654273	654369	654465	654562
452	655138	655235	655331	655427	655523
453	656098	656194	656289	656386	656482
454	657056	657152	657247	657343	657438
455	658011	658107	658202	658298	658393
456	658965	659060	659155	659250	659346
457	659916	660011	660106	660201	660296
458	660865	660960	661055	661149	661245
459	661813	661907	662002	662096	662191

5	6	7	8	9	D
633973	634075	634075	634276	634376	100
634981	635081	635182	635283	635383	100
635986	636087	636187	636288	636388	100
636989	637089	637189	637289	637389	100
637989	638089	638189	638289	638389	99
638988	639088	639188	639287	639387	99
639984	640084	640183	640283	640382	99
640978	641077	641177	641276	641375	99
641969	642069	642168	642267	642366	99
642959	643058	643156	643255	643354	99
643946	644044	644143	644242	644340	98
644931	645029	645127	645226	645324	98
645913	646011	646109	646208	646306	98
646894	646992	647089	647187	647285	98
647872	647969	648067	648165	648262	98
648848	648945	649043	649140	649237	97
649821	649919	650016	650113	650210	97
650793	650890	650987	651084	651181	97
651762	651859	651956	652053	652149	97
652729	652826	652923	653019	653116	97
653695	653791	653888	653984	654080	96
654658	654754	654850	654946	655042	96
655619	655715	655810	655906	656002	96
656577	656673	656769	656864	656960	96
657534	657629	657725	657820	657916	96
658488	658584	658679	658774	658869	95
659441	659536	659630	659726	659821	95
660391	660486	660581	660676	660771	95
661339	661434	661529	661623	661718	95
662289	662380	662475	662569	662663	95

N	0	1	2	3	4
460	662758	662852	662947	663041	663135
461	663701	663795	663889	663983	664078
462	664642	664736	664829	664924	665018
463	665581	665675	665769	665862	665956
464	666518	666611	666705	666799	666892
465	667453	667546	667639	667733	667826
466	668386	668479	668572	668665	668759
467	669317	669409	669503	669596	669689
468	670246	670339	670431	670524	670617
469	671173	671265	671358	671451	671543
470	672098	672190	672283	672375	672467
471	673021	673113	673205	673297	673389
472	673942	674034	674126	674218	674309
473	674861	674953	675045	675137	675228
474	675778	675869	675962	676053	676145
475	676694	676785	676876	676968	677059
476	677607	677698	677789	677881	677972
477	678518	678609	678700	678791	678882
478	679428	679519	679609	679700	679791
479	680336	680426	680517	680607	680698
480	681241	681332	681422	681513	681603
481	682145	682235	682326	682416	682506
482	683047	683137	683227	683317	683407
483	683947	684037	684127	684217	684307
484	684845	684935	685025	685114	685204
485	685742	685831	685921	686010	686099
486	686636	686326	686815	686904	686994
487	687529	687618	687707	687796	687885
488	688419	688509	688598	688687	688776
489	689309	689398	689486	689575	687664

5	6	7	8	9	D
663229	663324	663418	663512	663607	94
664172	664266	664359	664454	664548	94
665112	665206	665299	665393	665487	94
666049	666143	666237	666331	666424	94
666986	667079	667173	667266	667359	94
667919	668013	668106	668199	668293	93
668852	668945	669038	669131	669224	93
669782	669875	669967	670060	670153	93
670709	670802	670895	670988	671080	93
671636	671728	671821	671913	672005	93
672559	672652	672744	672836	672929	92
673482	673574	673666	673758	673849	92
674402	674494	674586	674677	674769	92
675319	675412	675503	675595	675687	92
676236	676328	676419	676511	676602	92
677151	677242	677333	677424	677516	91
678063	678154	678245	678335	678427	91
678973	679064	679155	679246	679337	91
679882	679972	680063	680154	680245	91
680789	680879	680969	681060	681151	91
681693	681784	681874	681964	682055	90
682596	682686	682777	682867	682957	90
683497	683587	683677	683767	683857	90
684396	684486	684576	684666	684756	90
685294	685383	685473	685563	685652	90
686189	686279	686368	686458	686547	89
687083	687172	687211	687351	687439	89
687975	688054	688153	688242	688331	89
688865	688953	689042	689131	689220	89
689753	689841	689930	690019	690007	89

N	0	1	2	3	4
490	690196	690285	690373	690462	690550
491	691081	691169	691258	691347	691435
492	691965	692053	692142	692229	692318
493	692847	692935	693023	693111	693199
494	693727	693815	693903	693991	694078
495	694605	694693	694781	694868	694956
496	695482	695569	695657	695744	695832
497	696356	696444	696531	696618	696706
498	697229	697317	697404	697491	697578
499	698101	698188	698275	698362	698449
500	698970	699057	699144	699281	699317
501	699838	699924	700011	700098	700184
502	700704	700790	700877	700963	701049
503	701568	701654	701741	701827	701913
504	702430	702517	702603	702689	702775
505	703291	793377	703463	703549	703635
506	704151	704236	704322	704408	704494
507	705008	705094	705179	705265	705350
508	705863	705949	706035	706130	706206
509	706718	706803	706888	706974	707059
510	707570	707655	707740	707826	707911
511	708421	708506	708591	708676	708761
512	709269	709355	709439	709524	709609
513	710117	710202	710287	710371	710456
514	710963	711048	711132	711217	711301
515	711807	711891	711976	712060	712144
516	712649	712734	712818	712902	712986
517	713491	713575	713659	713742	713826
518	714329	714414	714497	714581	714665
519	715167	715251	715335	715418	715501

5	6	7	8	9	D
690639	690728	690816	690905	690993	89
691524	691612	691700	691789	691877	88
692406	692494	692583	692671	692759	88
693287	693375	693463	693551	693639	88
694166	694254	694342	694429	694517	88
695044	695131	695219	695307	695394	88
695919	696007	696094	696182	696269	87
696793	696880	696968	697055	697142	87
697665	697752	697839	697926	698014	87
698535	698622	698709	698706	698883	87
699404	699491	699528	699664	699751	87
700271	700358	700444	705031	700617	87
701136	701222	701309	701395	701482	86
701999	702086	702172	702258	702344	86
702861	702947	703033	703119	703205	86
703721	703807	703893	703979	704065	86
704579	704665	704751	704837	704922	86
705436	705522	705607	705693	705778	86
706291	706376	706462	706547	706632	85
707144	707219	707315	707399	707485	85
707996	708081	708166	708251	708336	85
708846	708931	709015	709100	709185	85
709694	709789	709863	709948	710033	85
710540	710625	710709	710794	710879	85
711385	711469	711554	711639	711723	84
712229	712313	712397	712481	712566	84
713070	713154	713238	713223	713407	84
713910	713994	714078	714162	714246	84
714749	714833	714916	714999	715084	84
715586	715669	715753	715836	715919	84

N	0	1	2	3	4
520	716003	716087	716170	716254	716337
521	716838	716921	717004	717088	717171
522	717671	717754	717837	717920	718003
523	718502	718585	718668	718751	718834
524	719331	719414	719497	719579	719663
525	720159	720242	720325	720407	720490
526	720986	721068	721151	721233	721316
527	721811	721893	721975	722058	722140
528	722634	722716	722798	722881	722963
529	723456	723538	723619	723702	723784
530	724276	724358	724439	724522	724604
531	725095	725176	725258	725339	725422
532	725912	725993	726075	726156	726238
533	726727	726809	726890	726972	727053
534	727541	727623	727704	727785	727866
535	728354	728435	728516	728597	728678
536	729165	729246	729327	729408	729489
537	729974	730055	730136	730117	730298
538	730782	730863	730944	731024	731105
539	731589	731669	731749	731830	731911
540	732394	732474	732555	732635	732715
541	733197	733278	733358	733438	733518
542	733999	734079	734159	734239	734319
543	734799	734879	734959	735039	735119
544	735599	735679	735759	735838	735918
545	736397	736476	736556	736635	736715
546	737191	737272	737352	737431	737511
547	737987	738067	738146	738225	738305
548	738781	738859	738939	739018	739097
549	739572	739651	739731	739809	739889

5	6	7	8	9	D
716421	716504	716588	716671	716754	83
717254	717338	717421	717509	717587	83
718086	718169	718253	718336	718419	83
718917	718999	719083	719165	719248	83
719745	719828	719911	719994	720077	83
720573	720655	720738	720821	720903	83
721398	721481	721563	721646	721728	82
722222	722305	722387	722469	722552	82
723045	723127	723209	723291	723374	82
723866	723948	724029	724112	724194	82
724685	724767	724849	724931	725013	82
725503	725585	725667	725748	725829	82
726319	726401	726483	726564	726646	82
727134	727216	727297	727379	727459	81
727948	728029	728110	728191	728273	81
728759	728841	728922	729003	729084	81
729569	729651	729732	729813	729893	81
730378	730459	730540	730621	730702	81
731186	731266	731347	731423	731508	81
731991	732072	732152	732233	732313	81
732796	732876	732956	733037	733117	80
733598	733679	733759	733839	733919	80
734399	734479	734559	734639	734719	80
735199	735279	735359	735439	735519	80
735998	736078	736157	736237	736317	80
736795	736874	736954	737034	737113	80
737590	737669	737749	737829	737908	79
738384	738463	738543	738622	738701	79
739177	739259	739335	739414	739493	79
739968	740047	740126	740205	740284	79

N	0	1	2	3	4
550	740363	740442	740521	740599	740678
551	741152	741230	741309	741388	741467
552	741939	742018	742096	742175	742254
553	742725	742802	742882	742961	743039
554	743509	743588	743667	743745	743823
555	744293	744371	744449	744528	744606
556	745075	745153	745231	745309	745387
557	745855	745933	746011	746089	746167
558	746634	746712	746789	746868	746945
559	747412	747489	747567	747645	747722
560	748188	748266	748343	748421	748498
561	748963	749040	749118	749195	749272
562	749736	749814	749891	749968	750045
563	750508	750586	750663	750739	750817
564	751279	751356	751433	751510	751587
565	752048	752125	752202	752279	752356
566	752816	752893	752969	753047	753123
567	753583	753659	753736	753813	753889
568	754348	754425	754501	754578	754654
569	755112	755189	755265	755341	755417
570	755875	755951	756027	756103	756179
571	756636	756712	756788	756864	756940
572	757396	757472	757548	757627	757699
573	758155	758230	758306	758382	758458
574	758912	758988	759063	759139	759214
575	759668	759743	759819	759894	759969
576	760422	760498	760573	760649	760723
577	761176	761251	761326	761402	761477
578	761928	762003	762078	762153	762228
579	762679	762754	762829	762904	762978

5	6	7	8	9	D
740757	740836	740915	740994	741073	79
741546	741624	741703	741782	741860	79
742332	742411	742489	742568	742647	79
743118	743196	743275	743353	743431	78
743902	743979	744058	744136	744215	78
744684	744764	744840	744919	744997	78
745465	745543	745621	745699	745777	78
746245	746323	746401	746479	746556	78
747023	747101	747179	747256	747334	78
747800	747878	747955	748033	748110	78
748576	748653	748731	748808	748885	77
749349	749427	749504	749582	749659	77
750123	750199	750277	750354	750431	77
750894	750971	751048	751125	751202	77
751664	751741	751818	751895	751972	77
752433	752509	752586	752663	752739	77
753199	753277	753353	753429	753506	77
753966	754042	754119	754195	754272	77
754730	754800	754883	754959	755036	76
755494	755569	755646	755722	755799	76
756256	756332	756408	756484	756960	76
757016	757092	757167	757244	757320	76
757775	757851	757927	758003	758079	76
758533	758609	758685	758761	758836	76
759290	759366	759411	759517	759592	76
760045	760121	760196	760272	760347	75
760799	760875	760949	761025	761101	75
761552	761627	761702	761778	761853	75
762303	762378	762453	762529	762604	75
763053	763128	763203	763279	763353	75

N	0	1	2	3	4
580	763428	763503	763578	763653	763727
581	764176	764251	764326	764400	764475
582	764923	764998	765072	765147	765221
583	765669	765743	765818	765892	765966
584	766413	766487	766562	766636	766710
585	767156	767230	767304	767379	767453
586	767898	767972	768046	768119	768194
587	768638	768712	768786	768860	768934
588	769377	769451	769525	769599	769673
589	770115	770189	770263	770336	770410
590	770852	770926	770999	771073	771146
591	771587	761661	771734	771808	771881
592	772322	772395	772468	772542	772615
593	773055	773128	773201	773274	773348
594	773786	773859	773933	774006	774079
595	774517	774589	774663	774736	774809
596	775246	775319	775392	775465	775538
597	775974	776047	776119	776193	776265
598	776701	776774	776846	776919	776992
599	777427	777499	777572	777644	777717
600	778151	778224	778296	778368	778441
601	778874	778947	779019	779091	779163
602	779596	779669	779741	779813	779884
603	780317	780389	780461	780533	780805
604	781037	781109	781181	781253	781324
605	781755	781827	781899	781971	782042
606	782473	782544	782616	782688	782759
607	783189	783260	783332	783403	783475
608	783904	783975	784046	784118	784189
609	784617	784689	784759	784831	784902

5	6	7	8	9	D
763802	763877	763952	764027	764101	75
764549	764624	764699	764774	764848	75
765296	765370	765445	765519	765594	75
766041	766115	766189	766264	766338	74
766785	766859	766933	767007	767082	74
767527	767601	767675	767749	767823	74
768268	768342	768416	768490	768564	74
769008	769082	769156	769229	769303	74
769746	799820	769894	769968	770042	74
770484	770557	770631	770705	770778	74
771219	771293	771367	771440	771514	74
771955	772028	772102	772175	772248	73
772688	772762	772835	772908	772981	73
773421	773494	773567	773640	773713	73
774152	774225	774298	774371	774444	73
774882	774955	775028	775100	775173	73
775610	775683	775756	775829	775902	73
776338	776411	776483	776556	776629	73
777064	777137	777209	777282	777354	73
777789	777862	777934	778006	778079	72
778513	778585	778658	778729	778802	72
779236	779308	779380	779452	779524	72
779957	780029	780101	780173	780245	72
780677	780749	780821	780893	780965	72
781396	781468	781539	781612	781684	72
782114	782186	782258	782329	782401	72
782831	782902	782974	783046	783117	72
783546	783618	783689	783761	783832	71
784261	784332	784403	784475	784546	71
784974	785045	785116	785187	785259	71

N	0	1	2	3	4
610	785329	785401	785472	785543	785615
611	786041	786112	786183	786254	786325
612	786751	786822	786893	786964	787035
613	787460	787531	787602	787673	787744
614	788164	788239	788309	788381	788451
615	788875	788946	789016	789087	789157
616	789581	789651	789722	789792	789863
617	790285	790356	790426	790496	790567
618	790988	791059	791129	791199	791269
619	791691	791761	791831	791901	791971
620	792392	792462	792532	792602	792672
621	793092	793162	793231	793301	793371
622	793791	793860	793930	793999	794069
623	794488	794558	794627	794697	794767
624	795185	795254	795324	795393	795463
625	795880	795949	796019	796088	796158
626	796574	796644	796713	796782	796852
627	797268	797337	797406	797475	797545
628	797959	798029	798098	798167	798236
629	798651	798719	798789	798858	798927
630	799341	799409	799478	799547	799616
631	800029	800098	800167	800236	800305
632	800717	800786	800854	800923	800992
633	801404	801472	801541	801609	801678
634	802089	802158	802226	802295	802363
635	802774	802842	802910	802979	803047
636	803457	803525	803594	803662	803730
637	804139	804208	804276	804344	804412
638	804821	804889	804957	805025	805093
639	805501	805569	805637	805705	805773

5	6	7	8	9	D
785686	785757	785828	785899	78597c	71
786396	786467	786538	786609	786680	71
787106	787177	787248	787319	787389	71
787815	787885	787956	788027	788098	71
788522	788593	788663	788734	788804	71
789228	789299	789369	789439	789510	71
789933	790004	790074	790144	790215	70
790637	790707	790778	790848	790918	70
791339	791409	791480	791550	791620	70
792041	792111	792181	792252	792322	70
792742	792812	792882	792952	793022	70
793441	793511	793581	793651	793721	70
794139	794209	794279	794349	794418	70
794836	794906	7949 6	795045	795115	70
795532	795602	795672	795741	795810	70
796227	796297	796366	796436	796505	69
796921	796990	797059	797129	797198	69
797614	797683	797752	797821	797890	69
798305	798374	798443	798513	798582	69
798996	799065	799134	799203	799272	69
799685	799754	799823	799892	799961	69
800373	800442	800511	800579	800648	69
801061	801129	801198	801266	801335	69
801747	801815	801884	801952	802021	69
802432	802500	802568	802637	802705	69
803116	803184	803252	803321	803389	68
803798	803867	803935	804003	804071	68
804480	804548	804616	804685	804753	68
805161	805229	805297	805365	805433	68
805841	805908	805976	806044	806112	68

N	0	1	2	3	4
640	806179	806248	806316	806384	806451
641	806858	806926	806994	807061	807129
642	807535	807603	807670	807738	807806
643	808211	808279	808346	808414	808481
644	808886	808953	809021	809088	809156
645	809559	809627	809694	809762	809829
646	810233	810299	810367	810434	810501
647	810904	810971	811039	811106	811173
648	811575	811642	811709	811776	811843
649	812245	812312	812379	812445	812512
650	812913	812980	813047	813114	813181
651	813581	813648	813714	813781	813848
652	814248	814314	814381	814447	814514
653	814913	814979	815046	815113	815129
654	815578	815644	815711	815777	815843
655	816241	816308	816374	816440	816506
656	816904	816910	817036	817102	817169
657	817565	817631	817698	817764	817829
658	818226	818292	818358	818424	818489
659	818885	818951	819017	819083	819149
660	819543	819609	819676	819741	819807
661	820201	820267	820333	820399	820464
662	820858	820924	820989	821055	821120
663	821514	821509	821645	821709	821775
664	822168	822233	822299	822364	822429
665	822822	822887	822952	823018	823083
666	823474	823539	823605	823669	823735
667	824126	824191	824256	824321	824386
668	824776	824841	824906	824971	825036
669	825426	825491	825556	825621	825686

5	6	7	8	9	D
806519	806587	806655	806723	806790	68
807197	807264	807332	807399	807467	68
807873	807941	808008	808076	808143	68
808549	808616	808684	808751	808818	67
809223	809298	809358	809425	809492	67
809866	809964	810031	810098	810165	67
810569	810636	810703	810770	810837	67
811239	811307	811374	811441	811508	67
811969	811977	812044	812111	812178	67
812579	812646	812713	812779	812847	67
813247	813314	813381	813448	813514	67
813914	813981	814048	814114	814181	67
814581	814647	814714	814780	814847	67
815246	815312	815378	815445	815511	66
815909	815978	816042	816109	816175	66
816573	816639	816705	816771	816838	66
817235	817301	817367	817433	817499	66
817896	817962	818028	818094	818159	66
818556	818622	818688	818754	818819	66
819215	819281	819346	819412	819478	66
819873	819939	820004	820070	820136	66
820529	820595	820661	820727	820792	66
821186	821251	821317	821382	821448	66
821841	821906	821972	822037	822103	65
822495	822560	822626	822691	822756	65
823148	823213	823279	823344	823409	65
823800	823865	823930	823996	824061	65
824451	824516	824581	824646	824711	65
825101	825166	825231	825296	825361	65
825751	825815	825880	825945	826009	65

N	0	1	2	3	4
670	826075	826139	826204	826269	826334
671	826723	826787	826852	826917	826981
672	827369	827434	827499	827563	827628
673	828015	828079	828144	828209	828273
674	828659	828724	828789	828853	828918
675	829304	829368	829432	829497	829561
676	829947	830011	830075	830139	830204
677	830589	830653	830717	830781	830845
678	831229	831294	831358	831422	831486
679	831869	831934	831998	832062	832126
680	832509	832573	832637	832700	832764
681	833147	833211	833275	833338	833402
682	833784	833848	833912	833975	834039
683	834421	834484	834548	834611	834675
684	835056	835119	835183	835247	835310
685	835691	835754	835817	835881	835944
686	836324	836387	836451	836514	836577
687	836957	837019	837083	837146	837209
688	837588	837652	837715	837777	837841
689	838219	838282	838345	838408	838471
690	838849	838912	838975	839038	839101
691	839478	839541	839604	839667	839729
692	840106	840169	840232	840394	840357
693	840733	840796	840859	840921	840984
694	841359	841423	841485	841547	841609
695	841985	842047	842109	842172	842235
696	842609	842672	842734	842796	842859
697	843233	843295	843357	843419	843482
698	843855	843918	843979	844042	844104
699	844477	844539	844601	844664	844726

5	6	7	8	9	D
826399	826464	826528	826593	826658	65
827046	827111	827175	827239	827305	65
827692	827757	827822	827886	827951	65
828338	828402	828467	828531	828595	64
828982	829046	829111	829175	829239	64
829625	829689	829754	829818	829882	64
830268	830332	830396	830460	830525	64
830909	830973	831037	831102	831166	64
831549	831614	831678	831742	831806	64
833189	832253	832317	832381	832445	64
832828	832892	832956	833019	833083	64
833466	833529	833593	833657	833721	64
834103	834166	834229	834294	834357	64
834739	834802	834866	834929	834993	64
835373	835437	835500	835564	835627	63
836007	836071	836134	836197	836261	63
836641	836704	836767	836830	836894	63
837273	837339	837399	837462	837525	63
837904	837967	838030	838093	838156	63
838534	838597	838660	838723	838786	63
839164	839227	839289	839352	839415	63
839792	839855	839918	839981	840043	63
840419	840482	840545	840608	840671	63
841049	841109	841172	841234	841297	63
841672	841735	841797	841859	841922	63
842297	842359	842432	842484	842547	62
842921	842983	843046	843108	843170	62
843544	843606	843669	843731	843293	62
844166	844229	844291	844353	844415	62
844788	844849	844912	844974	845036	62

N	0	1	2	3	4
700	845098	845160	845222	845284	845346
701	845718	845779	845842	845904	845666
702	846337	846399	846461	846523	846585
703	846955	847017	847079	847141	847202
704	847573	847634	847696	847758	847819
705	848189	848251	848312	848374	848435
706	848805	848866	848928	848989	849051
707	849419	849481	849542	849604	849665
708	850032	850095	850156	850217	850279
709	850646	850707	850769	850829	850891
710	851258	851319	851381	851442	851503
711	851869	851931	851992	852053	852114
712	852479	852541	852602	852663	852724
713	853089	853150	853211	853272	853339
714	853698	853759	853819	853881	853941
715	854306	854367	854428	854488	854549
716	853913	854974	855034	855095	855156
717	855519	855579	855640	855701	855761
718	856124	856183	856245	856306	856366
719	856729	856789	856849	856910	856970
720	857332	857393	857453	857513	857574
721	857935	857993	858056	858116	858176
722	858537	858597	858657	858718	858778
723	859138	859198	859258	859318	859379
724	859739	859799	859859	859918	859978
725	860338	860398	860458	860518	860578
726	860037	860996	861056	861116	861176
727	861534	861594	861654	861714	861773
728	862131	862191	862251	862310	862369
729	862728	862787	862847	862906	862966

5	6	7	8	9	D
845408	845470	845532	845594	845656	62
846028	846089	846151	846213	846275	62
846646	846708	846769	846832	846894	62
847264	847326	847388	847449	847511	62
847881	847943	848004	848067	848128	62
848497	848559	848620	848682	848743	62
849112	849174	849235	849297	849358	61
849726	849788	849849	849911	849972	61
850339	850401	850462	850524	850585	61
850952	851014	851075	851136	851197	61
851564	851625	851686	851747	851809	61
852175	852236	852297	852358	852419	61
852785	852846	852907	852968	853029	61
853394	853455	853516	853577	853637	61
854002	854063	854124	854185	851245	61
854609	854670	854731	854792	854852	61
855216	855277	855337	855398	855459	61
855822	855882	855943	856003	856064	61
856427	856487	856548	856608	856668	60
857031	857091	857152	857212	857272	60
857634	857694	857755	857815	857875	60
858236	858297	858357	858417	858477	60
858838	858898	858958	859018	859078	60
859439	859499	859559	859619	859679	60
860038	860098	860158	860218	860278	60
860637	860697	860757	860817	860877	60
861236	861295	861355	861415	861475	60
861833	861893	861952	862012	862072	60
862429	862489	862549	862608	862668	60
863025	863085	863144	863204	863623	60

N	0	1	2	3	4
730	863323	863382	863442	863501	863561
731	863917	863977	864036	864096	864155
732	864511	864570	864629	864689	864748
733	865104	865163	865222	865282	865341
734	865696	865755	865814	865874	865933
735	866187	866346	866405	866465	866524
736	866878	866937	866996	867055	867114
737	867467	867526	867585	867644	867703
738	868056	868115	868174	868233	868292
739	868643	868703	868762	868821	868879
740	869232	869290	869349	869408	869466
741	869818	869877	869935	869994	870053
742	870404	870462	870521	870579	870638
743	870989	871047	871106	871164	871223
744	871573	871631	871689	871748	871806
745	872156	872215	872273	872331	872389
746	872739	872797	872855	872913	872972
747	873321	873379	873437	873495	873553
748	873902	873959	874018	874076	874134
749	874482	874539	874598	874656	874714
750	875061	875119	875177	875235	875293
751	875639	875698	875756	875813	875871
752	876218	876276	876333	876391	876449
753	876795	876853	876910	876968	877026
754	877371	877429	877487	877544	877602
755	877947	878004	878062	878119	878177
756	878522	878579	878637	878694	878752
757	879096	879153	879211	879268	879325
758	879669	879726	879784	879841	879898
759	870242	880299	880356	880413	880471

5	6	7	8	9	D
863620	863679	863739	863799	863858	59
864214	864274	864333	864392	864452	59
864808	864867	864926	864985	865045	59
865400	865459	865519	865578	865637	59
865992	866051	866110	866169	866228	59
866583	866642	866701	866759	866819	59
867173	867232	867291	867349	867409	59
867762	867821	867879	867939	867998	59
868350	868409	868468	868527	868586	59
868938	868997	869056	869114	869173	59
869525	869584	869642	869701	869759	59
870111	870169	870228	870287	870345	59
870696	870755	870813	870872	870930	59
871281	871339	871398	871456	871515	58
871865	871923	871981	871039	872098	58
872448	872506	872564	872622	872681	58
873029	873088	873146	873204	873262	58
873611	873669	873727	873785	873844	58
874192	874249	874308	874366	874424	58
874772	874829	874888	874945	875003	58
875351	875409	875466	875524	875582	58
875929	875987	876045	876102	876160	58
876507	876564	876622	876679	876737	58
877083	877141	877199	877256	877314	58
877659	877717	877774	877832	877889	58
878234	878292	878349	878407	878464	57
878808	878866	878924	878981	879039	57
879382	879439	879497	879555	879612	57
879955	880013	880070	880127	880185	57
880527	880585	880642	880699	880756	57

N	0	1	2	3	4
760	880814	880871	880928	880985	881042
761	881385	881442	881499	881556	881613
762	881955	882012	882069	882126	882183
763	882525	882581	882638	882695	882752
764	883095	883150	883207	883264	883321
765	883661	883718	883775	883832	883888
766	884229	884285	884342	884399	884455
767	884795	884852	884909	884965	885022
768	885361	885418	885474	885531	885587
769	885926	885983	886039	886096	886152
770	886491	886547	886604	886659	886716
771	887054	887111	887167	887223	887279
772	887617	887674	887729	887786	887842
773	888179	888236	888292	888348	888404
774	888741	888797	888853	888909	888965
775	889302	889358	889414	889469	889523
776	889862	889918	889974	890029	890086
777	890421	890477	890533	890589	890645
778	890979	891035	891091	891147	891203
779	891537	891593	891649	891705	891760
780	892095	892150	892206	892262	892317
781	898651	892707	892762	892818	892818
782	893207	893262	893318	893373	893429
783	893762	893817	893873	893928	893984
784	894316	894371	894427	894482	894538
785	894869	894925	894980	895036	895091
786	895423	895478	895533	895588	895644
787	895975	896029	896085	896140	896195
788	896526	896581	896636	896692	896747
789	897077	897132	897184	897242	897297

5	6	7	8	9	D
881099	881156	881213	881271	881328	57
881669	881727	881784	881841	881898	57
882239	882297	882354	882411	882468	57
882809	882866	882923	882979	883037	57
883377	883434	883491	883548	883605	57
883945	884002	884059	884115	884172	57
884512	884569	884625	884682	884739	57
885078	885135	885192	885248	885305	57
885644	885700	885757	885813	885869	57
886209	886265	886321	886378	886434	56
886773	886829	886885	886941	886998	56
887336	887392	887449	887505	887561	56
887898	887955	888011	888067	888123	56
888460	888516	888573	888629	888685	56
889021	889077	889134	889189	889246	56
889582	889638	889694	889749	889806	56
890141	890197	890253	890309	890365	56
890700	890756	890812	890868	890924	56
891259	891314	891370	891426	891482	56
891816	891872	891928	891983	892039	56
892373	892429	892484	892539	892595	56
892929	892985	893040	893096	893151	56
893484	893539	893595	893651	893706	56
894039	894094	894149	894205	894261	55
894593	894648	894704	894759	894814	55
895146	895201	895257	895312	895367	55
895699	895754	895809	895864	895919	55
896251	896306	896361	896416	896471	55
896802	896857	896912	896967	897022	55
897352	897407	897462	897517	897572	55

N	0	1	2	3	4
790	897627	897682	897737	897792	897847
791	898176	898231	898286	898341	898396
792	898725	898780	898835	898889	898944
793	899273	899328	899383	899437	899492
794	899821	899875	899929	899985	900039
795	900367	900422	900476	900531	900586
796	900913	900968	901022	901077	901131
797	901458	901513	901567	901622	901676
798	902003	902057	902112	902166	902221
799	902547	902601	902655	902709	902764
800	903089	903144	903199	903253	903307
801	903633	903687	903741	903795	903849
802	904174	904229	904283	904337	904391
803	904716	904769	904824	904878	904932
804	905256	905310	905364	905418	905472
805	905796	905849	905904	905958	906012
806	906335	906389	906443	906497	906551
807	906874	906927	907981	907035	907089
808	907411	907465	907519	907573	907626
809	907949	908002	908056	908109	908163
810	908485	908539	908592	908646	908699
811	909021	909074	909128	909181	909235
812	905556	909609	909663	909716	909769
813	910091	910144	910197	910251	910304
814	910624	910678	910731	910784	910838
815	911158	911211	911263	911317	911371
816	911690	911743	911797	911849	911903
817	912222	912275	912323	912381	912435
818	912753	912806	912859	912913	912966
819	913284	913337	913380	913443	913496

5	6	7	8	9	D
897902	897957	898012	898067	898122	55
898451	898506	898561	898615	898670	55
898999	899054	899109	899164	899218	55
899547	899602	899656	899711	899766	55
900094	900149	900203	900258	900312	55
900640	900695	900749	900804	900859	55
901186	901240	901295	901349	901404	55
901731	901785	901839	901894	901948	54
902275	902329	902384	902438	902492	54
902818	902873	902927	902981	903036	54
903361	903416	903469	903524	903578	54
903904	903956	904012	904066	904120	54
904445	904499	904553	904607	904661	54
904986	905039	905094	905148	905202	54
905526	905580	905634	905688	905742	54
906066	906119	906173	906227	906281	54
906604	906658	906712	906766	906819	54
907143	907196	907250	907304	907358	54
907680	907734	907787	907841	907895	54
908217	908270	908324	908378	908431	54
908753	908807	908860	908914	908967	54
909289	909341	909396	909449	909503	54
909823	909877	909930	909984	910037	53
910358	910411	910464	910518	910571	53
910891	910944	910998	911051	911104	53
911424	911477	911530	911584	911637	53
911956	912009	912063	912116	912169	53
912488	912541	912594	912647	912700	53
913019	913072	913125	913178	913231	53
913549	913602	913655	913708	913761	53

N	0	1	2	3	4
820	913814	913867	913919	913973	914026
821	914343	914396	914449	914502	914555
822	914872	914925	914977	915030	915083
823	915399	915453	915505	915558	915611
824	915927	915979	916033	916085	916138
825	916454	916507	916559	916612	916664
826	916980	917033	917085	917138	917190
827	917506	917558	917611	917663	917716
828	918030	918083	918135	918188	918240
829	918555	918607	918659	918712	918764
830	919078	919130	919183	919235	919287
831	919601	919653	919706	919758	919810
832	920123	920176	920228	920279	920332
833	920645	920697	920749	920801	920853
834	921166	921218	921270	921322	921374
835	921686	921738	921790	921842	921894
836	922206	922258	922310	922362	922414
837	922725	922777	922829	922881	922933
838	923244	923296	923348	923399	923451
839	923762	923814	923865	923917	923969
840	924279	924331	924383	924434	924486
841	924796	924848	924899	924951	925003
842	925312	925364	925415	925461	925518
843	925828	925879	925931	925982	926034
844	926342	926394	926445	926497	926548
845	926857	926908	926959	927011	927062
846	927370	927422	927473	927524	927576
847	927883	927935	927986	928037	928088
848	928396	928447	928498	928549	928601
849	928908	928959	929009	929061	929112

5	6	7	8	9	D
914079	914132	914184	914237	914290	53
914608	914660	914713	914766	914819	53
915136	915189	915241	915294	915347	53
915664	915716	915769	915822	915875	53
916191	916243	916296	916349	916401	53
916717	916769	916822	916875	916927	53
917243	917295	917348	917400	917453	53
917768	917820	917873	917925	917978	52
918293	918345	918397	918449	918502	52
918816	918869	918921	918973	919026	52
919339	919392	919444	919496	919549	52
919862	919914	919967	920019	920071	52
920384	920436	920489	920541	920593	52
920906	920958	921009	921062	921114	52
921426	921478	921530	921582	921634	52
921946	921998	922050	922102	922154	52
922466	922518	922569	922622	922674	52
922985	923037	923089	923140	923192	52
923503	923555	923607	923658	923710	52
924021	924072	924124	924176	924228	52
924538	924589	924641	924693	924744	52
925054	925106	925157	925209	925261	52
925569	925621	925673	925725	925776	52
926085	926137	926188	926239	926291	51
926599	926651	926702	926754	926805	51
927114	927165	927216	927268	927319	51
927627	927678	927729	927781	927832	51
928139	928191	928242	928293	928345	51
928652	928703	928754	928805	928857	51
929163	929215	929266	929317	929368	51

N	0	1	2	3	4
850	929419	929470	929521	929572	929623
851	929929	929981	930032	930083	930134
852	930439	930491	930542	930592	930643
853	930949	930999	931051	931102	931153
854	931458	931509	931559	931610	931661
855	931966	932017	932068	932118	932169
856	932474	932524	932575	932626	932677
857	932981	933031	933082	933133	933183
858	933487	933538	933589	933639	933689
859	933993	934044	934094	934145	934195
860	934498	934549	934599	934649	934700
861	935003	935056	935104	935154	935205
862	935507	935558	935608	935658	935709
863	936011	936061	936111	936162	936212
864	936514	936564	936614	936665	936715
865	937016	937066	937117	937167	937217
866	937518	937568	937618	937668	937718
867	938019	938069	938119	938169	938219
868	938519	938569	938619	938669	938719
869	939019	939069	939119	939169	939219
870	939519	939569	939619	939669	939719
871	940018	940068	940118	940168	940218
872	940516	940566	940616	940666	940716
873	941014	941064	941114	941163	941213
874	941511	941561	941611	941660	941710
875	942008	942058	942107	942157	942207
876	942504	942554	942603	942653	942702
877	942999	943049	943099	943148	943198
878	943495	943544	943594	943643	943692
879	943989	944038	944088	944137	944186

5	6	7	8	9	D
929674	929725	929776	929827	929879	51
930185	930236	930287	930338	930389	51
930694	930745	930796	930847	930898	51
931204	931254	931305	931356	931407	51
931712	931763	931814	931865	931915	51
932220	932271	932322	932372	932423	51
932727	932778	932829	932879	932930	51
933234	933284	933335	933386	933437	51
933740	933791	933841	933892	933943	51
934246	934296	934347	934397	934448	51
934751	934801	934852	934902	934953	50
935255	935306	935356	935406	935457	50
935759	935809	935859	935910	935960	50
936262	936313	936363	936413	936463	50
936765	936815	936865	936916	936966	50
937267	937317	937367	937418	937468	50
937769	937819	937869	937919	937969	50
938269	938319	938369	938419	938469	50
938769	938819	938869	938919	938969	50
939269	939319	939369	939419	939469	50
939769	939819	939869	939918	939968	50
940267	940317	940367	940417	940467	50
940765	940815	940865	940915	940964	50
941263	941313	941362	941412	941462	50
941759	941809	946859	941909	941958	50
942256	942306	942355	942405	942455	50
942752	942801	942851	942901	942950	50
943247	943297	943346	943496	943445	49
943742	943791	943841	943890	943939	49
944236	944285	944335	944384	944433	49

N	0	1	2	3	4
880	944483	944532	944581	944631	944680
881	944976	945025	945074	945124	945873
882	945468	945518	945567	945616	945665
883	945961	946009	946059	946108	946157
884	946452	946501	946551	946599	946649
885	946943	946992	947041	947090	947139
886	947434	947483	947532	947581	947629
887	947924	947973	948022	948070	948119
888	948413	948462	948511	948559	948609
889	948902	948951	948999	949048	949097
890	949390	949439	949488	949536	949585
891	949878	949926	949975	950024	950073
892	950365	950414	950462	950511	950559
893	950851	950900	950949	950997	951046
894	951338	951386	951435	951483	951532
895	951823	951872	951920	951969	952017
896	952308	952356	952405	952453	952502
897	952792	952841	952889	952938	952986
898	953276	953325	953373	953421	953469
899	953759	953808	953856	953905	953953
900	954243	954292	954339	954387	954435
901	954725	954773	954821	954869	954918
902	955207	955255	955303	955351	955399
903	955688	955736	955784	955832	955880
904	956168	956216	956265	956313	956361
905	956649	956697	956745	956793	956840
906	957128	957176	957224	957272	957319
907	957607	957655	957703	957751	957799
908	958086	958134	958181	958229	958277
909	958564	958612	958659	958707	958755

5	6	7	8	9	D
944729	944779	944828	944877	944927	49
945222	945272	945321	945370	945419	49
945715	945764	945813	945862	945912	49
946207	946256	946305	946354	946403	49
946698	946747	946796	946845	946894	49
947189	947238	947287	947336	947385	49
947679	947728	947777	947826	947875	49
948168	948217	948266	948315	948364	49
948657	948706	948755	948804	948853	49
949146	949195	949244	949292	949341	49
949633	949683	949731	949780	949829	49
950121	950170	950219	950267	950316	49
950608	950657	950706	950754	950803	49
951095	951143	951192	951240	951289	49
951580	951629	951677	951729	951775	49
952066	952114	952163	952210	952259	49
952550	952399	952647	952696	952744	48
953034	953083	953131	953179	953228	48
953518	953566	953615	953663	953711	48
954001	954049	954099	954146	954194	48
954484	954532	954580	954628	954677	48
954966	955014	955062	955110	955158	48
955447	955495	955543	955592	955639	48
955928	955976	956024	956075	956120	48
956409	956457	956505	956533	956601	48
956888	956936	956984	957032	957080	48
957368	957416	957464	957512	957559	48
957847	957894	957942	957900	958038	48
958325	958373	958421	958468	958516	48
958803	958850	958898	958946	958994	48

N	0	1	2	3	4
910	959041	959089	959137	959185	959231
911	959518	959566	959614	959661	959709
912	959995	960042	960090	960138	960185
913	960471	960518	960566	960613	960661
914	960946	960994	961041	961089	961136
915	961421	961469	961516	961563	961611
916	961895	961943	961990	962038	962085
917	962369	962417	962464	962511	962559
918	962842	962886	962937	962985	963032
919	963315	963363	963410	963457	963504
920	963788	963835	963882	963929	963977
921	964259	964307	964354	964401	964448
922	964731	964778	964825	964872	964919
923	965202	965249	965296	965343	965389
924	965672	965719	965766	965813	965859
925	966142	966189	966239	966283	966329
926	966611	966658	966705	966752	966799
927	967079	967127	967173	967220	967267
928	967548	967595	967642	967688	967735
929	968016	968062	968109	968156	968202
930	968483	968529	968576	968623	968669
931	968949	968996	969043	969089	969136
932	969416	969463	969509	969556	969602
933	969882	969928	969975	970021	970068
934	970347	970393	970439	970486	970533
935	970812	970858	970904	970951	970997
936	971286	971322	971369	971415	971461
937	971739	971786	971832	971879	971925
938	972203	972249	972295	972342	972388
939	972666	972712	972758	972804	972851

5	6	7	8	9	D
959279	959328	959375	959423	959471	48
959757	959804	959852	959899	959947	48
960233	960280	960328	960376	960423	48
960709	960756	960804	960851	960899	48
961184	961231	961279	961326	961374	47
961658	961706	961753	961801	961848	47
962132	962179	962227	962275	962322	47
962606	962653	962701	969748	962795	47
963079	963126	963174	963221	963268	47
963552	963599	963646	963693	963741	47
964024	964071	964118	964165	964212	47
964495	964542	964589	964637	964684	47
964966	965013	965061	965108	965155	47
965437	965484	965531	965578	965624	47
965906	965954	966001	966048	966095	47
966376	966423	966470	966517	966564	47
966845	966892	966939	966986	967033	47
967314	967361	967408	967454	967501	47
967782	967829	967875	967922	967969	47
968249	968296	968343	968389	968436	47
968716	968763	968809	968856	968902	47
969183	969229	969276	969323	969369	47
969649	969695	969741	969789	969835	47
970114	970161	970207	970254	970300	47
970579	970626	970672	970719	970765	46
971044	971090	971137	971183	971229	46
971508	971554	971601	971647	971693	46
971971	972018	972064	972110	972157	46
972434	972481	972527	972573	972619	46
972897	972943	972989	973035	973082	46

N	0	1	2	3	4
940	973128	973174	973220	973266	973313
941	973589	973636	973682	973728	973774
942	974050	974097	974143	974189	974235
943	974512	974558	974604	974649	974695
944	974972	975018	975064	975109	975156
945	975432	975478	975524	975569	975616
946	975891	975937	975983	976029	976075
947	976349	976396	976442	976488	976533
948	976808	976854	976899	976946	976992
949	977266	977312	977358	977403	977449
950	977724	977769	977815	977861	977906
951	978181	978226	978272	978317	978363
952	978637	978683	978728	978774	978819
953	979093	979138	979184	979229	979275
954	979548	979594	979639	979685	979730
955	980003	980049	980094	980139	980185
956	980458	980503	980549	980594	980639
957	980912	980957	981003	981048	981093
958	981366	981411	981456	981501	981547
959	981819	981864	981909	981954	981999
960	982271	982316	982362	982407	982452
961	982723	982769	982814	982859	982904
962	983175	983220	983265	983310	983356
963	983626	983671	983716	983762	983807
964	984077	984122	984167	984212	984257
965	984527	984572	984617	984662	984707
966	984977	985022	985067	985112	985157
967	985426	985471	985516	985561	985606
968	985875	985920	985965	986009	986055
969	986324	986369	986413	986458	986504

5	6	7	8	9	D
973359	973405	973451	973497	973543	46
973820	973866	973913	973959	974005	46
974281	974327	974374	974419	974466	46
974742	974788	974834	974819	974926	46
975202	975248	975294	975339	975386	46
975662	975707	975753	975799	975845	46
976121	976167	976212	976258	976304	46
976579	976625	976671	976717	976763	46
977037	977083	977129	977175	977220	46
977495	977541	977586	977632	977678	46
977952	977998	978042	978089	978135	46
978409	978454	978500	978546	978591	46
978865	978911	978956	979002	979047	46
979321	979366	979412	979457	979503	46
979776	979821	979867	979912	979958	46
980231	980276	980322	980367	980412	45
980685	980730	980776	980821	980867	45
981139	981184	981229	981275	981320	45
981592	981637	981683	981728	981773	45
982045	982090	982135	982181	982226	45
982497	982543	982588	982633	982678	45
982949	982994	983039	983085	983129	45
983401	983446	983490	983536	983581	45
983852	983897	983942	983987	984032	45
984302	984347	984392	984437	984482	45
984752	984797	984842	984887	984932	45
985202	985247	985292	985337	985382	45
985651	985696	985741	985786	985830	45
986099	986144	986189	986234	986279	45
986548	986593	986637	986682	986727	45

N	0	1	2	3	4
970	986772	986817	986861	986906	986951
971	987219	987264	987309	987353	987398
972	987666	987711	987756	987800	987845
973	988113	988157	988202	988247	988291
974	988559	988604	988748	988693	988737
975	989005	989049	989094	989138	989183
976	989449	989494	989539	989584	989628
977	989895	989939	989983	990028	990072
978	990339	990383	990428	990472	990516
979	990783	990827	990871	990916	990960
980	991226	991270	991315	991359	991403
981	991669	991713	991758	991802	991846
982	992111	992156	992199	992244	992288
983	992554	992598	992642	992686	992730
984	992995	993039	993083	993127	993172
985	993436	993480	993524	993568	993613
986	993877	993921	993965	994009	994053
987	994317	994361	994405	994449	994493
988	994756	994801	994845	994889	994933
989	995196	995240	995284	995328	995372
990	995635	995679	995723	995764	995811
991	996074	996117	996161	996205	996249
992	996512	996555	996599	996643	996687
993	996949	996993	997037	997080	997124
994	997386	997430	997474	997517	997561
995	997823	997867	997910	997954	997998
996	998259	998303	998347	998390	998434
997	998695	998739	998783	998826	998869
998	999133	999174	999218	999261	999305
999	999565	999609	999652	999696	999739

5	6	7	8	9	D
986996	987040	987085	987129	987175	45
987443	987488	987532	987577	987622	45
987889	987934	987979	988024	988068	45
988336	988381	988425	988469	988514	45
988782	988826	988871	988916	988960	45
989227	989272	989316	989361	989405	45
989672	989717	989761	989806	989850	44
990117	990161	990206	980150	990294	44
990561	990605	990649	990694	990738	44
991004	991049	991093	991137	991182	44
991448	991492	991536	991580	991625	44
991890	991935	991979	992023	992067	44
992333	992377	992421	992465	992509	44
992774	992819	992863	992907	992951	44
993216	993259	993304	993348	993392	44
993657	993701	993745	993789	993833	44
994097	994141	994185	994229	994273	44
994537	994581	994625	994669	994713	44
994977	995021	995065	995108	995152	44
995416	995459	995504	995547	995591	44
995854	995898	995942	995986	996029	44
996293	996337	996380	996424	996468	44
996731	996774	996818	996862	996906	44
997168	997212	997255	997299	997343	44
997605	997648	997692	997736	997779	44
998041	998085	998129	998170	998216	44
998477	998521	998564	998608	998652	44
998913	998956	998999	999043	999087	44
999348	999392	999435	999479	999522	44
999783	999826	999869	999913	999957	43

A

TABLE

OF

PROPORTIONAL PARTS,

WHEREBY

The *Intermediate Logarithms* of all Numbers,

AND

The Numbers of all *Logarithms* from 10000 to 100000 may more readily be found out by the foregoing Table of *Logarithms.*

LONDON,

Printed by *J. Heptinſtall* for *W. Freeman*, at the *Artichoke* next St. *Dunſtan's* Church in *Fleetſtreet*. MDCLXXXVII.

TABLE
OF
Proportional Parts.

D	1	2	3	4	5	6	7	8	9
43	4	8	12	17	21	25	30	34	38
44	4	8	13	17	22	26	30	35	39
45	4	9	13	18	22	27	31	36	40
46	4	9	13	18	23	27	32	36	41
47	4	9	14	18	23	28	32	37	42
48	4	9	14	19	24	28	33	38	43
49	4	9	14	19	24	29	34	39	44
50	5	10	15	20	25	30	35	40	45
51	5	10	15	20	25	30	35	40	45
52	5	10	15	20	26	31	36	41	46
53	5	10	15	21	26	31	37	42	47
54	5	10	16	21	27	32	37	43	48
55	5	11	16	22	27	33	38	44	49
56	5	11	16	22	28	33	39	44	50
57	5	11	17	22	28	34	39	45	51
58	5	11	17	23	29	34	40	46	52
59	5	11	17	23	29	35	41	47	53
60	6	12	18	24	30	36	42	48	54
61	6	12	18	24	30	36	42	48	54
62	6	12	18	24	31	37	43	49	55

D	1	2	3	4	5	6	7	8	9
63	6	12	18	25	31	37	44	50	56
64	6	12	19	25	32	38	44	51	57
65	6	13	19	26	32	39	45	52	58
66	6	13	19	26	33	39	46	52	59
67	6	13	20	26	33	40	46	53	60
68	6	13	20	27	34	40	47	54	61
69	6	13	20	27	34	41	48	55	62
70	7	14	21	28	35	42	49	56	63
71	7	14	21	28	35	42	49	56	63
72	7	14	21	28	36	43	50	57	64
73	7	14	21	29	36	43	51	58	65
74	7	14	22	29	37	44	51	59	66
75	7	15	22	30	37	45	52	60	67
76	7	15	22	30	38	45	53	60	68
77	7	15	23	30	38	46	53	61	69
78	7	15	23	31	39	46	54	62	70
79	7	15	23	31	39	47	55	63	71
80	8	16	24	32	40	48	56	64	72
81	8	16	24	32	40	48	56	64	72
82	8	16	24	32	41	49	57	65	73
83	8	16	24	33	41	49	58	66	74
84	8	16	25	33	42	50	58	67	75
85	8	17	25	34	42	51	59	68	76
86	8	17	25	34	43	51	60	68	77
87	8	17	26	34	43	52	60	69	78
88	8	17	26	35	44	52	61	70	79
89	8	17	26	35	44	53	62	71	80
90	9	18	27	36	45	54	63	72	81
91	9	18	27	36	45	54	63	72	81
92	9	18	27	36	46	55	64	73	82

D	1	2	3	4	5	6	7	8	9
93	9	18	27	37	46	55	65	74	83
94	9	18	28	37	47	56	66	75	84
95	9	19	28	38	47	57	66	76	85
96	9	19	28	38	48	57	67	76	86
97	9	19	29	38	48	58	67	77	87
98	9	19	29	39	49	58	68	78	88
99	9	19	29	39	49	59	69	79	89
100	10	20	30	40	50	60	70	80	90
101	10	20	30	40	50	60	70	80	90
102	10	20	30	40	51	61	71	81	91
103	10	20	30	41	51	61	72	82	92
104	10	20	31	41	52	62	72	83	93
105	10	21	31	42	52	63	73	84	94
106	10	21	31	42	53	63	74	84	95
107	10	21	32	42	53	64	74	85	96
108	10	21	32	43	54	64	75	86	97
109	10	21	32	43	54	65	76	87	98
110	11	22	33	44	55	66	77	88	99
111	11	22	33	44	55	66	77	88	99
112	11	22	33	44	56	67	78	89	100
113	11	22	33	45	57	67	78	90	101
114	11	22	34	45	57	68	79	91	102
115	11	23	34	46	57	69	80	92	103
116	11	23	34	46	58	69	81	92	104
117	11	23	35	46	58	70	81	73	105
118	11	23	35	47	59	70	82	94	106
119	11	23	35	47	59	71	83	95	107
120	12	24	36	48	60	72	84	96	108
121	12	24	36	48	60	72	84	96	108
122	12	24	36	48	61	73	85	97	109

D	1	2	3	4	5	6	7	8	9
123	12	24	36	48	61	73	86	98	110
124	12	24	37	49	62	74	86	99	111
125	12	25	37	50	62	75	87	100	112
126	12	25	37	50	63	75	88	100	113
127	12	25	38	50	63	76	88	101	114
128	12	25	38	51	64	76	89	102	115
129	12	25	38	51	64	77	90	103	116
130	13	26	39	52	65	78	91	104	117
131	13	26	39	52	65	78	91	104	117
132	13	26	39	52	66	79	92	105	118
133	13	26	39	53	66	79	93	106	119
134	13	26	40	53	67	80	93	107	120
135	13	27	40	54	67	81	94	108	121
136	13	27	40	54	68	81	95	108	122
137	13	27	41	54	68	82	95	109	123
138	13	27	41	55	69	82	96	110	124
139	13	27	41	55	69	83	97	111	125
140	14	28	42	56	70	84	98	112	126
141	14	28	42	56	70	84	99	112	126
142	14	28	42	56	71	85	99	113	127
143	14	28	42	57	71	85	100	114	128
144	14	28	43	57	72	86	100	115	129
145	14	28	43	58	72	87	101	116	130
146	14	29	43	58	73	87	102	116	131
147	14	29	44	58	73	88	102	117	132
148	14	29	44	59	74	88	103	118	133
149	14	29	44	59	74	89	104	119	134
150	15	30	45	60	75	90	105	120	135
151	15	30	45	60	75	90	105	120	135
152	15	30	45	60	76	91	106	121	136

D	1	2	3	4	5	6	7	8	9
153	15	30	45	60	76	91	107	122	137
154	15	30	46	61	77	92	107	123	138
155	15	31	46	62	77	93	108	124	139
156	15	31	46	62	78	93	109	124	140
157	15	31	47	62	78	94	109	125	141
158	15	31	47	63	79	94	110	126	142
159	15	31	47	63	79	95	111	127	143
160	16	32	48	64	80	96	112	128	144
161	16	32	48	64	80	96	112	128	144
162	16	32	48	64	81	97	113	129	145
163	16	32	48	65	82	98	114	130	146
164	16	32	49	66	82	98	114	131	147
165	16	33	49	66	82	99	115	132	148
166	16	33	49	66	83	99	116	132	149
167	16	33	50	66	83	100	116	133	150
168	16	33	50	67	84	100	117	134	151
169	17	33	50	67	84	101	118	135	152
170	17	34	51	68	85	102	119	136	153
171	17	34	51	68	85	102	119	136	153
172	17	34	51	68	86	103	120	137	154
173	17	34	51	69	86	103	121	138	155
174	17	34	52	69	87	104	121	139	156
175	17	34	52	70	87	105	122	140	157
176	17	35	52	70	88	105	123	140	158
177	17	35	53	70	88	106	123	141	159
178	17	35	53	71	89	106	124	142	160
179	17	35	53	71	89	107	125	143	161
180	18	36	54	72	90	108	126	144	162
181	18	36	54	72	90	108	126	144	162
182	18	36	54	72	91	109	127	145	163

D	1	2	3	4	5	6	7	8	9
183	18	36	54	73	91	109	128	146	164
184	18	36	55	73	92	110	128	147	165
185	18	37	55	74	92	111	129	148	166
186	18	37	55	74	93	111	130	148	167
187	18	37	56	74	83	112	130	149	168
188	18	37	56	75	94	112	131	150	169
189	18	37	56	75	94	113	132	151	170
190	19	38	57	76	95	114	133	152	171
191	19	38	57	76	55	114	133	152	171
192	19	38	57	76	96	115	134	153	172
193	19	38	57	77	96	115	135	154	173
194	19	38	58	77	97	116	135	155	174
195	19	39	58	78	97	117	136	156	175
196	19	39	59	78	98	117	136	156	176
197	19	39	59	78	98	118	137	157	177
198	19	39	59	79	99	118	138	158	178
199	19	39	59	79	99	119	139	159	179
200	20	40	60	80	100	120	140	160	180
201	20	40	60	80	100	120	140	160	180
202	20	40	60	80	101	121	141	161	181
203	20	40	60	81	101	121	142	162	182
204	20	40	61	81	102	122	142	163	183
205	20	41	61	82	102	123	143	164	184
206	20	41	61	82	103	123	144	164	185
207	20	41	62	82	103	124	144	165	186
208	20	41	62	83	104	124	145	166	187
209	20	41	62	83	104	125	146	167	188
210	21	42	63	84	105	126	147	168	189
211	21	42	63	84	105	126	147	168	189
212	21	42	63	84	106	127	148	169	190

D	1	2	3	4	5	6	7	8	9
213	21	42	63	85	106	127	149	170	191
214	21	42	64	85	107	128	149	171	192
215	21	43	64	86	107	129	150	172	193
216	21	43	64	86	108	129	151	172	194
217	21	43	65	86	108	130	151	173	195
218	21	43	65	87	109	130	152	174	196
219	21	43	65	87	109	131	153	175	197
220	22	44	66	88	110	132	154	176	198
221	22	44	66	88	110	132	154	176	198
222	22	44	66	88	111	133	155	177	199
223	22	44	66	89	111	133	156	178	200
224	22	44	67	89	112	134	156	179	201
225	22	45	67	90	112	135	157	180	202
226	22	45	67	90	113	135	158	180	203
227	22	45	68	90	113	136	158	181	204
228	22	45	68	91	114	136	159	182	205
229	22	45	68	91	114	137	160	183	206
230	23	46	69	92	115	138	161	184	207
231	23	46	69	92	115	138	161	184	207
232	23	46	69	92	116	139	162	185	208
233	23	46	69	93	116	139	163	186	209
234	23	46	70	93	117	140	163	187	210
235	23	47	70	94	117	141	164	188	211
236	23	47	70	94	118	141	165	188	212
237	23	47	71	94	118	142	165	189	213
238	23	47	71	95	119	142	166	190	214
239	23	47	71	95	119	143	167	191	215
240	24	48	72	96	120	144	168	192	216
241	24	48	72	96	120	144	168	192	216
242	24	48	72	96	121	145	169	193	217

D	1	2	3	4	5	6	7	8	9
243	24	48	72	97	121	145	170	194	218
244	24	48	73	97	122	146	170	195	219
245	24	49	73	98	122	147	171	196	220
246	24	49	73	98	123	147	172	196	221
247	24	49	74	98	123	148	172	197	222
248	24	49	74	99	124	148	173	198	223
249	24	49	74	99	124	149	174	199	224
250	25	50	75	100	125	150	175	200	225
251	25	50	75	100	125	150	175	200	225
252	25	50	75	100	126	151	176	201	226
253	25	50	75	101	126	151	177	202	227
254	25	50	76	101	127	152	177	203	228
255	25	50	76	102	127	153	178	204	229
256	25	51	76	102	128	153	179	204	230
257	25	51	77	102	128	154	179	205	231
258	25	51	77	103	129	154	180	206	232
259	25	51	77	103	129	155	181	207	233
260	26	52	78	104	130	156	182	208	234
261	26	52	78	104	130	156	182	208	234
262	26	52	78	104	131	156	183	209	235
263	26	52	78	105	131	157	184	210	236
264	26	52	79	105	132	158	184	211	237
265	26	53	79	106	132	159	185	212	238
266	26	53	79	106	133	159	186	212	239
267	26	53	80	106	133	160	186	213	240
268	26	53	80	107	134	160	187	214	241
269	26	53	80	107	134	161	188	215	242
270	27	54	81	108	135	162	189	216	243
271	27	54	81	108	135	162	189	216	243
272	27	54	81	108	136	163	190	217	244

D	1	2	3	4	5	6	7	8	9
273	27	54	81	109	136	163	191	218	245
274	27	54	82	109	137	164	191	219	246
275	27	55	82	110	137	165	192	220	247
276	27	55	82	110	138	165	193	220	248
277	27	55	83	110	138	166	193	221	249
278	27	55	83	111	139	166	194	222	250
279	27	55	83	111	139	167	195	223	251
280	28	56	84	112	140	168	196	224	252
281	28	56	84	112	140	168	196	224	252
282	28	56	84	112	141	169	197	225	253
283	28	56	84	113	141	169	198	226	254
284	28	56	85	113	142	170	198	227	255
285	28	57	85	114	142	171	199	228	256
286	28	57	85	114	143	171	200	228	257
287	28	57	86	114	143	172	200	229	258
288	28	57	86	115	144	172	201	230	259
289	28	57	86	115	144	173	202	231	260
290	29	58	87	116	145	174	203	232	261
291	29	58	87	116	145	174	203	232	261
292	29	58	87	116	146	175	204	233	262
293	29	58	87	117	146	175	205	234	263
294	29	58	88	117	147	176	205	235	264
295	29	59	88	118	147	177	206	236	265
296	29	59	88	118	148	177	207	236	266
297	29	59	88	118	148	178	207	237	267
298	29	59	89	119	149	178	208	238	268
299	29	59	89	119	149	179	209	239	269
300	30	60	90	120	150	180	210	240	270
301	30	60	90	120	150	180	210	240	270
302	30	60	90	120	151	181	211	241	271

D	1	2	3	4	5	6	7	8	9
303	30	60	90	121	151	181	212	242	272
304	30	60	91	121	152	182	212	243	273
305	30	61	91	122	152	183	213	244	274
306	30	61	91	122	153	183	214	244	275
307	30	61	92	122	153	184	214	245	276
308	30	61	92	123	154	184	215	246	277
309	30	61	92	123	154	185	216	247	278
310	31	62	93	124	155	186	217	248	279
311	31	62	93	124	155	186	217	248	279
312	31	62	93	124	156	187	218	249	280
313	31	62	93	125	156	187	219	250	281
314	31	62	94	125	157	188	219	251	282
315	31	63	94	126	157	189	220	252	283
316	31	63	94	126	158	189	221	252	284
317	31	63	95	126	158	190	221	253	285
318	31	63	95	127	159	190	222	254	286
319	31	63	95	127	159	191	223	255	287
320	32	64	96	128	160	192	224	256	288
321	32	64	96	128	160	192	224	256	288
322	32	64	96	128	161	193	225	257	289
323	32	64	96	129	161	193	226	258	290
324	32	64	97	129	162	194	226	259	291
325	32	65	97	130	162	195	227	260	292
326	32	65	97	130	163	195	228	260	293
327	32	65	98	130	163	196	228	261	294
328	32	65	98	131	163	196	229	262	295
329	32	65	98	131	164	197	230	263	296
330	33	66	99	132	165	198	231	264	297
331	33	66	99	132	165	198	231	264	297
332	33	66	99	132	166	199	232	265	298

D	1	2	3	4	5	6	7	8	9
333	33	66	99	133	166	199	233	266	299
334	33	66	100	133	167	200	233	267	300
335	33	67	100	134	167	201	234	268	301
336	33	67	100	134	168	201	235	268	302
337	33	67	101	134	168	202	235	269	303
338	33	67	101	135	169	202	236	270	304
339	33	67	101	135	169	203	237	271	305
340	34	68	102	136	170	204	238	272	306
341	34	68	102	136	170	204	238	272	306
342	34	68	102	136	171	205	239	273	307
343	34	68	102	137	171	205	240	274	308
344	34	68	103	137	172	206	240	275	309
345	34	69	103	138	172	207	241	276	310
346	34	69	103	138	173	207	242	276	311
347	34	69	104	138	173	208	242	277	312
348	34	69	104	139	174	208	243	278	313
349	34	69	104	139	174	209	244	279	314
350	35	70	105	140	175	210	245	280	315
351	35	70	105	140	175	210	245	280	315
352	35	70	105	140	176	211	246	281	316
353	35	70	105	141	176	211	247	282	317
354	35	70	106	141	177	212	247	283	318
355	35	71	106	142	177	213	248	284	319
356	35	71	106	142	178	213	249	284	320
357	35	71	107	142	178	214	249	285	321
358	35	71	107	143	179	214	250	286	322
359	35	71	107	143	179	215	251	287	323
360	36	72	108	144	180	216	252	288	324
361	36	72	108	144	180	216	252	288	324
362	36	72	108	144	181	217	253	289	325

D	1	2	3	4	5	6	7	8	9
363	36	72	108	145	181	217	254	290	326
364	36	72	109	145	182	218	254	291	327
365	36	73	109	146	182	219	255	292	328
366	36	73	109	146	182	219	256	292	329
367	36	73	110	146	183	220	256	293	330
368	36	73	110	147	184	220	257	294	331
369	36	73	110	147	184	221	258	295	332
370	37	74	111	148	185	222	259	296	333
371	37	74	111	148	185	222	259	296	333
372	37	74	111	148	186	223	260	297	334
373	37	74	111	149	186	223	261	298	335
374	37	74	112	149	187	224	261	299	336
375	37	75	112	150	187	225	262	300	337
376	37	75	112	150	188	225	263	300	338
377	37	75	113	150	188	226	263	301	339
378	37	75	113	151	189	226	264	302	340
379	37	75	113	151	189	227	265	303	341
380	38	76	114	152	190	228	266	304	342
381	38	76	114	152	190	228	266	304	342
382	38	76	114	152	191	229	267	305	343
383	38	76	114	153	191	229	268	306	344
384	38	76	115	153	192	230	268	307	345
385	38	77	115	154	192	231	269	308	346
386	38	77	115	154	193	231	270	308	347
387	38	77	116	154	193	232	270	309	348
388	38	77	116	155	194	232	271	310	349
389	38	77	116	155	194	233	272	311	350
390	39	78	117	156	195	233	273	312	351
391	39	78	117	156	195	233	273	312	351
392	39	78	117	156	196	234	274	313	352

D	1	2	3	4	5	6	7	8	9
393	39	78	117	157	196	235	275	314	353
394	39	78	118	157	197	236	275	315	354
395	39	79	118	158	197	237	276	316	355
396	39	79	118	158	198	237	277	316	356
397	39	79	119	158	198	238	277	317	357
398	39	79	119	159	199	238	278	318	358
399	39	79	119	159	199	239	279	319	359
400	40	80	120	160	200	240	280	320	360
401	40	80	120	160	200	240	280	320	360
402	40	80	120	160	201	241	281	321	361
403	40	80	120	161	201	241	282	322	362
404	40	80	121	161	202	242	282	323	363
405	40	81	121	162	202	243	283	324	364
406	40	81	121	162	203	243	284	324	365
407	40	81	122	162	203	244	284	325	366
408	40	81	122	163	204	244	285	326	367
409	40	81	122	163	204	245	286	327	368
410	41	82	123	164	205	246	287	328	369
411	41	82	123	164	205	246	287	328	369
412	41	82	123	164	206	247	288	329	370
413	41	82	123	165	206	247	289	330	371
414	41	82	124	165	207	248	289	331	372
415	41	83	124	166	207	249	290	332	373
416	41	83	124	166	208	249	291	332	374
417	41	83	125	166	208	250	291	333	375
418	41	83	125	167	209	250	292	334	376
419	41	83	125	167	209	251	293	335	377
420	42	84	126	168	210	252	294	336	378
421	42	84	126	168	210	252	294	336	378
422	42	84	126	168	211	253	295	337	379

D	1	2	3	4	5	6	7	8	9
423	42	84	126	169	211	253	296	338	380
424	42	84	127	169	212	254	296	339	381
425	42	85	127	170	212	255	297	340	382
426	42	85	127	170	213	255	298	340	383
427	42	85	128	170	213	256	298	341	384
428	42	85	128	171	214	256	299	342	385
429	42	85	128	171	214	257	300	343	386
430	43	86	129	172	215	258	301	344	387
431	43	86	129	172	215	258	301	344	387
432	43	86	129	172	216	259	302	345	388
433	43	86	129	173	216	259	303	346	389
434	43	86	130	173	217	260	304	347	390
435	43	87	130	174	217	261	304	348	391

A Ta-

A

TABLE

OF

ARTIFICIAL SINES

AND

TANGENTS

To every

DEGREE and MINUTE

OF THE

QUADRANT.

LONDON,

Printed by *J. Heptinſtall* for *W. Freeman*, at the *Artichoke* next St. *Dunſtan's* Church in *Fleetſtreet*. MDCLXXXVII.

M.	Sine	*Co-sine*	Tangent	*Co-tang.*	
0	0.000000	10.000000	0.000000	*Infinita.*	60
1	6.463726	9.999999	6.463726	13.536274	59
2	6.764756	9.999999	6.764756	13.235244	58
3	6.940847	9.999999	6.940847	13.059153	57
4	7.065786	9.999999	7.065786	12.934214	56
5	7.162696	9.999999	7.162696	12.837304	55
6	7.241877	9.999999	7.241878	12.758122	54
7	7.308824	9.999999	7.308825	12.691175	53
8	7.366816	9.999999	7.366817	12.633183	52
9	7.417968	9.999999	7.417970	12.582030	51
10	7.463726	9.999998	7.463727	12.536273	50
11	7.505118	9.999998	7.505120	12.494880	49
12	7.542906	9.999997	7.542909	12.457091	48
13	7.577668	9.999997	7.577272	12.422328	47
14	7.609853	9.999996	7.609857	12.390143	46
15	7.639816	9.999996	7.639826	12.360180	45
16	7.667844	9.999995	7.667849	12.332151	44
17	7.694173	9.999995	7.694179	12.305821	43
18	7.718977	9.999994	7.719003	12.281997	42
19	7.742477	9.999993	7.742484	12.257516	41
20	7.764754	9.999993	7.764761	12.235239	40
21	7.785943	9.999992	7.785951	12.214049	39
22	7.806146	9.999991	7.806145	12.193845	38
23	7.825451	9.999990	7.825460	12.174540	37
24	7.843034	9.999989	7.843944	12.156056	36
25	7.861662	9.999989	7.861674	12.138326	35
26	7.878695	9.999988	7.878708	12.121292	34
27	7.895085	9.999987	7.895099	12.104901	33
28	7.910879	9.999986	7.910894	12.089106	32
29	7.926119	9.999985	7.926134	12.073866	31
30	7.940842	9.999983	7.940858	12.059142	30
	Co-sine	Sine	*Co-tang.*	Tangent	M

M	Sine	Co-fine	Tangent	Co-tang.	
30	7.940842	9.999983	7.940858	12.059142	30
31	7.955082	9.999982	7.955100	12.044900	29
32	7.968870	9.999981	7.968889	12.031111	28
33	7.982233	9.999980	7.982253	12.017747	27
34	7.995198	9.999978	7.995215	12.004781	26
35	8.007787	9.999978	8.007810	11.992191	25
36	8.020021	9.999976	8.020044	11.979956	24
37	8.031919	9.999975	8.031945	11.968055	23
38	8.043601	9.999973	8.043527	11.956473	22
39	8.054781	9.999972	8.054809	11.945181	21
40	8.065776	9.999971	8.065806	11.934194	20
41	8.076500	9.999969	8.076531	11.923469	19
42	8.086965	9.999968	8.086997	11.913003	18
43	8.097183	9.999966	8.097217	11.902783	17
44	8.107167	9.999964	8.107203	11.892797	16
45	8.116926	9.999963	8.116963	11.883037	15
46	8.126471	9.999961	8.126510	11.873490	14
47	8.135810	9.999959	8.135851	11.864149	13
48	8.144953	9.999958	8.144996	11.855004	12
49	8.153907	9.999956	8.153952	11.846048	11
50	8.162681	9.999954	8.162737	11.837273	10
51	8.171280	9.999952	8.171328	11.828672	9
52	8.179713	9.999950	8.179763	11.820237	8
53	8.187985	9.999948	8.188036	11.811964	7
54	8.196102	9.999946	8.196156	11.803844	6
55	8.204070	9.999944	8.204126	11.795674	5
56	8.211895	9.999942	8.211953	11.788047	4
57	8.219581	9.999940	8.219641	11.780359	3
58	8.227134	9.999938	8.227195	11.772805	2
59	8.234557	9.999936	8.234621	11.765379	1
60	8.241855	9.999934	8.241921	11.758079	0
	Co-fine	Sine	Co-tang.	Tangent	M

Degree 89.

4°0	Degree 1.				
M	Sine	*Co-sine*	Tangent	*Co-tang.*	
0	8.241855	9.999934	8.241921	11.758079	60
1	8.249033	9.999932	8.249102	11.750898	59
2	8.256094	9.999929	8.256165	11.743835	58
3	8.263042	9.999927	8.263115	11.736885	57
4	8.269881	9.999925	8.269956	11.730044	56
5	8.276614	9.999922	8.276691	11.723309	55
6	8.283243	9.999920	8.283323	11.716677	54
7	8.289773	9.999918	8.289856	11.716144	53
8	8.296207	9.999915	8.296292	11.703708	52
9	8.302546	9.999913	8.302634	11.697366	51
10	8.308794	9.999910	8.308884	11.691116	50
11	8.314954	9.999907	8.315046	11.684954	49
12	8.321027	9.999905	8.321122	11.678878	48
13	8.327016	9.999902	8.327114	11.672886	47
14	8.332924	9.999899	8.333025	11.666975	46
15	8.338753	9.999897	8.338856	11.661144	45
16	8.344504	9.999894	8.344610	11.655390	44
17	8.350180	9.999891	8.350289	11.649711	43
18	8.355783	9.999888	8.355895	11.644105	42
19	8.361315	9.999885	8.361430	11.638570	41
20	8.366777	9.999882	8.366895	11.633105	40
21	8.372171	9.999879	8.372292	11.627708	39
22	8.377499	9.999876	8.377622	11.622378	38
23	8.382762	9.999873	8.382889	11.617111	37
24	8.387962	9.999870	8.388092	11.611908	36
25	8.393101	9.999867	8.393234	11.606766	35
26	8.398179	9.999864	8.398315	11.601685	34
27	8.403199	9.999861	8.403338	11.596662	33
28	8.408161	9.999858	8.408304	11.591696	32
29	8.413068	9.999854	8.413213	11.586787	31
30	8.417919	9.999851	8.418068	11.581932	30
	Co-sine	Sine	*Co-tang.*	Tangent	M

Degree 88.

M	Sine	Co-sine	Tangent	Co-tang.	
30	8.417919	9.999851	8.418068	11.581932	30
31	8.422717	9.999848	8.422869	11.577131	29
32	8.427462	9.999844	8.427618	11.572382	28
33	8.432156	9.999841	8.432315	11.567685	27
34	8.436800	9.999838	8.436962	11.563038	26
35	8.441394	9.999834	8.441560	11.558440	25
36	8.445941	9.999831	8.446110	11.553990	24
37	8.450440	9.999827	8.450613	11.549387	23
38	8.454893	9.999824	8.455070	11.544930	22
39	8.459301	9.999820	8.459481	11.540519	21
40	8.463665	9.999816	8.463849	11.536151	20
41	8.467985	9.999812	8.468172	11.531828	19
42	8.472263	9.999809	8.472454	11.527546	18
43	8.476498	9.999805	8.476693	11.523307	17
44	8.480693	9.999801	8.480892	11.519108	16
45	8.484848	9.999797	8.485050	11.514950	15
46	8.488963	9.999794	8.486170	11.510830	14
47	8.493040	9.999790	8.483250	11.506750	13
48	8.497078	9.999786	8.497293	11.502707	12
49	8.501080	9.999782	8.501298	11.498702	11
50	8.505045	9.999778	8.505267	11.494733	10
51	8.508974	9.999774	8.509200	11.490800	9
52	8.512867	9.999769	8.513098	11.486902	8
53	8.516726	9.999765	8.516961	11.483039	7
54	8.520551	9.999761	8.520790	11.479210	6
55	8.524343	9.999756	8.524586	11.475414	5
56	8.528102	9.999753	8.528349	11.471651	4
57	8.531828	9.999748	8.532080	11.467620	3
58	8.535523	9.999744	8.535779	11.464221	2
59	8.539186	9.999740	8.539447	11.460553	1
60	8.542819	9.999735	8.543084	11.456916	0
	Co-sine	Sine	Co-tang.	Tangent	M

Degree 88.

M	Sine	Co-sine	Tangent	Co-tang.	
0	8.542819	9.999735	8.543084	11.456916	60
1	8.546422	9.999731	8.546691	11.453309	59
2	8.549995	9.999726	8.550268	11.449732	58
3	8.553558	9.999722	8.553817	11.446183	57
4	8.557054	9.999717	8.557336	11.442664	56
5	8.560540	9.999713	8.560827	11.439172	55
6	8.563999	9.999708	8.564291	11.435709	54
7	8.567431	9.999703	8.567727	11.432272	53
8	8.570836	9.999699	8.571137	11.428863	52
9	8.574214	9.999694	8.574520	11.425480	51
10	8.577566	9.999689	8.577877	11.422123	50
11	8.580892	9.999685	8.581208	11.418792	49
12	8.584193	9.999680	8.584514	11.415486	48
13	8.587469	9.999675	8.587795	11.412205	47
14	8.590721	9.999670	8.591051	11.408949	46
15	8.593948	9.999665	8.594283	11.405717	45
16	8.597152	9.999660	8.597492	11.402508	44
17	8.600332	9.999655	8.600677	11.399323	43
18	8.603488	9.999650	8.603838	11.396161	42
19	8.606622	9.999645	8.606978	11.393022	41
20	8.609734	9.999640	8.610094	11.389906	40
21	8.612823	9.999635	8.613189	11.386811	39
22	8.615891	9.999629	8.616262	11.383738	38
23	8.618937	9.999624	8.619313	11.380687	37
24	8.621967	9.999619	8.622343	11.377657	36
25	8.624965	9.999614	8.625352	11.374648	35
26	8.627948	9.999608	8.628340	11.371660	34
27	8.630911	9.9996c3	8.631308	11.368692	33
28	8.633854	9.999597	8.634456	11.365744	32
29	8.636776	9.999592	8.637184	11.362816	31
30	8.639679	9.999586	8.640093	11.359907	30
	Co-sine	Sine	Co-tang.	Tangent	M

M	Sine	Co-sine	Tangent	Co-tang.	
30	8.639679	9.999586	8.640093	11.359907	30
31	8.642563	9.999581	8.642982	11.357017	29
32	8.645428	9.999575	8.645853	11.354147	28
33	8.648274	9.999570	8.648704	11.351296	27
34	8.651102	9.999564	8.651538	11.348463	26
35	8.653911	9.999558	8.654352	11.345648	25
36	8.656702	9.999553	8.657149	11.342851	24
37	8.659475	9.999547	8.659928	11.340072	23
38	8.662230	9.999541	8.662689	11.337311	22
39	8.664968	9.999535	8.665433	11.334567	21
40	8.667689	9.999529	8.668160	11.331840	20
41	8.670393	9.999523	8.670869	11.329130	19
42	8.673080	9.999518	8.673563	11.326437	18
43	8.675751	9.999512	8.676239	11.323761	17
44	8.678405	9.999506	8.678899	11.321100	16
45	8.681043	9.999499	8.681544	11.318456	15
46	8.683665	9.999493	8.684172	11.315828	14
47	8.686272	9.999487	8.686784	11.313216	13
48	8.688892	9.999481	8.689381	11.310619	12
49	8.691438	9.999475	8.691963	11.308037	11
50	8.693998	9.999469	8.694529	11.305471	10
51	8.696543	9.999462	8.697081	11.302919	9
52	8.699073	9.999456	8.699617	11.300383	8
53	8.701589	9.999450	8.702139	11.297861	7
54	8.704090	9.999443	8.704646	11.295354	6
55	8.706576	9.999437	8.707130	11.292860	5
56	8.709049	9.999431	8.709618	11.290381	4
57	8.711507	9.999424	8.712083	11.287917	3
58	8.713952	9.999418	8.714534	11.285466	2
59	8.716383	9.999411	8.716972	11.283028	1
60	8.718800	9.999404	8.719396	11.280604	0
	Co-sine	Sine	Co-tang.	Tangent	M

Degree 87.

M	Sine	Co-sine	Tangent	Co-tang.	
0	8.718800	9.999404	8.719396	11.280604	60
1	8.721204	9.999398	8.721806	11.278194	59
2	8.723595	9.999391	8.724254	11.275796	58
3	8.725972	9.999384	8.726588	11.273412	57
4	8.728336	9.999378	8.728959	11.271041	56
5	8.730688	9.999371	8.731317	11.268683	55
6	8.733027	9.999364	8.733663	11.266337	54
7	8.735354	9.999357	8.735996	11.264004	53
8	8.737667	9 999350	8.738317	11.261683	52
9	8.739969	9.999343	8.740626	11.259374	51
10	8.742259	9.999336	8.742922	11.257078	50
11	8.744536	9.999329	8.745207	11.254793	49
12	8.746801	9.999322	8 747479	11.252521	48
13	8.745955	9.999315	8.749740	11.250240	47
14	8.751297	9.999308	8.751989	11.248011	46
15	8.753528	9.999301	8.754227	11.245773	45
16	8.755747	9.999294	8.756453	11.243542	44
17	8.757955	9.999286	8.758668	11.241332	43
18	8.760151	9.999279	8.760872	11.239128	42
19	8.762337	9.999272	8.763065	11 236935	41
20	8.764511	9.999265	8.765246	11.234754	40
21	8.766675	9.999257	8.767417	11.232583	39
22	8.768828	9.999250	8.769578	11.230422	38
23	8.770970	9.999242	8 771727	11.228273	37
24	8.773101	9.999235	8 773866	11.229134	36
25	8.775223	9.999227	8 775995	11.224005	35
26	8.777333	9.999220	8.778114	11.221886	34
27	8.779434	9.999212	8.783222	11.219778	33
28	8.781524	9.999204	8.782320	11.217680	32
29	8.783605	9.999197	8.784404	11.215592	31
30	8.785675	9.999189	8.786486	11.213514	30
	Co-sine	Sine	Co-tang.	Tangent	M

M	Sine	Co-fine	Tangent	Co-tang.	
30	8.785675	9.999189	8.786486	11.213514	30
31	8.787736	9.999181	8.788554	11.211446	29
32	8.789787	9.999174	8.790613	11.209387	28
33	8.791828	9.999166	8.792662	11.207338	27
34	8.793859	9.999158	8.794701	11.205299	26
35	8.795881	9.999150	8.796731	11.203269	25
36	8.797894	9.999142	8.798752	11.201248	24
37	8.799897	9.999134	8.800763	11.199237	23
38	8.801891	9.999126	8.802765	11.197235	22
39	8.803876	9.999118	8.804758	11.195242	21
40	8.805852	9.999110	8.806742	11.193258	20
41	8.807819	9.999102	8.808717	11.191283	19
42	8.809777	9.999094	8.812683	11.189317	18
43	8.811726	9.999086	8.812641	11.187359	17
44	8.813667	9.999077	8.814589	11.185411	16
45	8.815598	9.999069	8.816529	11.183471	15
46	8.817522	9.999061	8.818461	11.181539	14
47	8.819436	9.999052	8.8203 4	11.179616	13
48	8.821342	9.999044	8.822298	11.177702	12
49	8.823240	9.999036	8.824205	11.175795	11
50	8.825130	9.999027	8.826103	11.173897	10
51	8.827011	9.999019	8.827992	11.172008	9
52	8.828884	9.999010	8.829874	11.170126	8
53	8.830749	9.999002	8.831748	11.168252	7
54	8.832106	9.998993	8.833613	11.166387	6
55	8.834456	9.998984	8.835471	11.164529	5
56	8.836297	9.998976	8.837321	11.162679	4
57	8.838130	9.998967	8.839163	11.160837	3
58	8.839956	9.998958	8.840998	11.159002	2
59	8.841774	9.998940	8.842825	11.157175	1
60	8.843585	9.998941	8.844644	11.155356	0
	Co-fine	Sine	Co tang.	Tangent.	M

M	Sine	Co-sine	Tangent	Co-tang.	
0	8.843584	9.998941	8.844644	11.155356	60
1	8.845387	9.998931	8.846455	11.153545	59
2	8.847183	9.998923	8.848240	11.151740	58
3	8.848971	9.998914	8.850057	11.149943	57
4	8.850751	9.998905	8.851846	11.148154	56
5	8.852525	9.998896	8.853628	11.146372	55
6	8.854291	9.998887	8.855403	11.144597	54
7	8.856049	9.998878	8.857171	11.142829	53
8	8.857801	9.998869	8.858932	11.141068	52
9	8.859546	9.998860	8.860686	11.139314	51
10	8.861283	9.998851	8.862433	11.137567	50
11	8.863014	9.998841	8.864173	11.135827	49
12	8.864738	9.998832	8.865906	11.134094	48
13	8.866454	9.998823	8.867632	11.132368	47
14	8.868165	9.998813	8.869351	11.130649	46
15	8.869868	9.998804	8.871064	11.128936	45
16	8.871565	9.998795	8.872750	11.127230	44
17	8.873255	9.998785	8.874469	11.125531	43
18	8.874938	9.998776	8.876162	11.123838	42
19	8.876615	9.998766	8.897849	11.122151	41
20	8.878285	9.998757	8.879529	11.120471	40
21	8.879949	9.998747	8.881202	11.118798	39
22	8.881607	9.998738	8.882869	11.117131	38
23	8.883258	9.998728	8.884530	11.115470	37
24	8.884903	9.998718	8.886185	11.113815	36
25	8.886542	9.998708	8.887833	11.112167	35
26	8.888174	9.998699	8.889476	11.110524	34
27	8.889801	9.998689	8.891112	11.108888	33
28	8.891421	9.998679	8.892742	11.107258	32
29	8.893035	9.998669	8.894366	11.105634	31
30	8.894643	9.998659	8.845984	11.104016	30
	Co-sine.	Sine	Co-tang.	Tangent.	M

M	Sine	Co-sine	Tangent	Co-tang.	
30	8.894643	9.998659	8.895984	11.104016	30
31	8.896246	9.998649	8.897596	11.102404	29
32	8.897842	9.998639	8.899203	11.100797	28
33	8.899432	9.998629	8.900803	11.099197	27
34	8.901017	9.998619	8.902398	11.097602	26
35	8.902596	9.998609	8.903987	11.096013	25
36	8.904169	9.998599	8.905570	11.094430	24
37	8.905736	9.998589	8.907147	11.092853	23
38	8.907297	9.998577	8.908719	11.091281	22
39	8.908853	9.998568	8.910285	11.089715	21
40	8.910404	9.998558	8.911846	11.088154	20
41	8.911949	9.998548	8.913401	11.086599	19
42	8.913488	9.998537	8.914951	11.085049	18
43	8.915022	9.998527	8.916495	11.083505	17
44	8.916550	9.998516	8.918034	11.081966	16
45	8.918073	9.998506	8.919568	11.080432	15
46	8.919591	9.998495	8.921096	11.078904	14
47	8.921103	9.998485	8.922619	11.077381	13
48	8.922610	9.998474	8.924136	11.075864	12
49	8.924112	9.998464	8.925649	11.074351	11
50	8.925609	9.998453	8.927156	11.072844	10
51	8.927100	9.998442	8.928658	11.071342	9
52	8.928587	9.998431	8.930155	11.069845	8
53	8.930068	9.998421	8.931647	11.068353	7
54	8.931544	9.998410	8.933134	11.066866	6
55	8.933015	9.998399	8.934616	11.065384	5
56	8.934481	9.998388	8.936093	11.063907	4
57	8.935942	9.998377	8.937565	11.062435	3
58	8.937398	9.998366	8.939032	11.060968	2
59	8.938850	9.998355	8.940494	11.059506	1
60	8.940296	9.998344	8.941952	11.058048	0
	Co-sine	Sine	Co-tang.	Tangent.	M

M	Sine	Co-sine	Tangent	Co-tang.	
0	8.940296	9.998344	8.941952	11.058048	60
1	8.941738	9.998333	8.943404	11.056596	59
2	8.943174	9.998322	8.944852	11.055148	58
3	8.944606	9.998311	8.946295	11.053705	57
4	8.946034	9.998300	8.947734	11.052266	56
5	8.957456	9.998289	8.949168	11.050832	55
6	8.958814	9.998277	8.950597	11.049403	54
7	8.950287	9.998266	8.952021	11.047979	53
8	8.951696	9.998255	8.953441	11.046559	52
9	8.953099	9.998243	8.954856	11.045144	51
10	8.954499	9.998232	8.956267	11.043733	50
11	8.955894	9.998220	8.957674	11.042326	49
12	8.957284	9.998209	8.959075	11.040925	48
13	8.958670	9.998197	8.960473	11.039527	47
14	8.960052	9.998186	8.961866	11.038134	46
15	8.961429	9.998174	8.963254	11.036746	45
16	8.962801	9.998163	8.964639	11.035361	44
17	8.964170	9.998151	8.966019	11.033981	43
18	8.965534	9.998139	8.967394	11.032606	42
19	8.966893	9.998128	8.968766	11.031234	41
20	8.968249	9.998116	8.970133	11.029867	40
21	8.969600	9.998104	8.971495	11.028505	39
22	8.970947	9.998092	8.972855	11.027145	38
23	8.972289	9.998080	8.974209	11.025791	37
24	8.973626	9.998068	8.975560	11.024440	36
25	8.974962	9.998056	8.976906	11.023094	35
26	8.976293	9.998044	8.978248	11.021752	34
27	8.977619	9.998032	8.979586	11.020414	33
28	8.978941	9.998020	8.980921	11.019079	32
29	8.980259	9.998008	8.982251	11.017749	31
30	8.981573	9.997996	8.983577	11.016423	30
	Co-sine.	Sine	Co-tang.	Tangent.	M

M	Sine	Co-sine	Tangent	Co-tang.	
30	8.981573	9.997996	8.983577	11.016423	30
31	8.982883	9.997984	8.984899	11.015101	29
32	8.984189	9.997971	8.986217	11.013783	28
33	8.985491	9.997959	8.987532	11.012468	27
34	8.986789	9.997947	8.988842	11.011158	26
35	8.988083	9.997935	8.990149	11.009851	25
36	8.989374	9.997922	8.991451	11.008549	24
37	8.990660	9.997910	8.992750	11.007250	23
38	8.991943	9.997897	8.994045	11.005955	22
39	8.993228	9.997885	8.995337	11.004663	21
40	8.994497	9.997873	8.996624	11.003376	20
41	8.995768	9.997860	8.997908	11.002092	19
42	8.997036	9.997847	8.999188	11.000812	18
43	8.998299	9.997835	9.000465	10.999535	17
44	8.999560	9.997822	9.001738	10.998262	16
45	9.000816	9.997809	9.003007	10.996993	15
46	9.002069	9.997797	9.004272	10.995728	14
47	9.003318	9.997784	9.005534	10.994466	13
48	9.004563	9.997771	9.006792	10.993208	12
49	9.005805	9.997758	9.008047	10.991953	11
50	9.007044	9.997730	9.009298	10.990708	10
51	9.008278	9.997732	9.010546	10.989454	9
52	9.009510	9.997719	9.011790	10.988210	8
53	9.010737	9.997706	9.013031	10.986969	7
54	9.011962	9.997693	9.014268	10.985732	6
55	9.013182	9.997680	9.015502	10.984498	5
56	9.014399	9.997667	9.016732	10.983268	4
57	9.015613	9.997654	9.017959	10.982041	3
58	9.016824	9.997641	9.019183	10.980817	2
59	9.018031	9.997628	9.020403	10.979597	1
60	9.019235	9.997612	9.021620	10.978380	0
	Co-sine	Sine	Co-tang.	Tangent	M

430 Degree 6

M	Sine	Co-sine	Tangent	Co-tang.	
0	9.019235	9.997614	9.021620	10.978380	60
1	9.020435	9.997601	9.022834	10.977166	59
2	9.021632	9.997588	9.024044	10.975956	58
3	9.022825	9.997574	9.025251	10.974749	57
4	9.024016	9.997561	9.026455	10.973545	56
5	9.025203	9.997548	9.027655	10.972345	55
6	9.026386	9.997534	9.028852	10.971148	54
7	9.027567	9.997520	9.030046	10.969954	53
8	9.028744	9.997507	9.031237	10.968763	52
9	9.029918	9.997493	9.032425	10.967575	51
10	9.031089	9.997480	9.033609	10.966391	50
11	9.032257	9.997466	9.034791	10.965209	49
12	9.033421	9.997452	9.035969	10.964031	48
13	9.034582	9.997439	9.036144	10.962856	47
14	9.035741	9.997425	9.038316	10.961684	46
15	9.036896	9.997411	9.039485	10.960515	45
16	9.038048	9.997397	9.040651	10.959349	44
17	9.039197	9.997383	9.041813	10.958187	43
18	9.040342	9.997369	9.042973	10.957027	42
19	9.041485	9.997355	9.044130	10.955870	41
20	9.042625	9.997341	9.045284	10.954716	40
21	9.043762	9.997327	9.046434	10.953566	39
22	9.044895	9.997313	9.047582	10.952418	38
23	9.046026	9.997299	9.048727	10.951273	37
24	9.047154	9.997285	9.049869	10.950131	36
25	9.049279	9.997271	9.051008	10.948992	35
26	9.049400	9.997256	9.052144	10.947856	34
27	9.050519	9.997242	9.043277	10.946723	33
28	9.051635	9.997228	9.054408	10.945592	32
29	9.052749	9.997214	9.055535	10.944465	31
30	9.053859	9.997199	9.056640	10.943340	30
	Co-sine	Sine	Co-tang.	Tangent	M

Degree 83.

Degree 6. 431

M	Sine	Co-sine	Tangent	Co-tang.	
30	9.053859	9.997199	9.056640	10.943340	30
31	9.054966	9.997185	9.057781	10.942219	29
32	9.056071	9.997170	9.058900	10.941100	28
33	9.057172	9.997156	9.060016	10.939984	27
34	9.058271	9.997141	9.061130	10.938870	26
35	9.059367	9.997127	9.062240	10.937760	25
36	9.060460	9.997112	9.063348	10.936652	24
37	9.061551	9.997098	9.064453	10.935547	23
38	9.062638	9.997083	9.065556	10.934444	22
39	9.063723	9.997068	9.066655	10.933345	21
40	9.064806	9.997053	9.067752	10.932248	20
41	9.065885	9.997039	9.068847	10.931153	19
42	9.066962	9.997024	9.069938	10.930062	18
43	9.063036	9.997009	9.071027	10.928973	17
44	9.069107	9.996994	9.072113	10.927887	16
45	9.070176	9.996979	9.073197	10.926803	15
46	9.071242	9.996964	9.074278	10.925722	14
47	9.072306	9.996949	9.075356	10.924644	13
48	9.073366	9.996934	9.076432	10.923568	12
49	9.074424	9.996919	9.077505	10.922495	11
50	9.075480	9.996904	9.078576	10.921424	10
51	9.076533	9.996889	9.079644	10.920356	9
52	9.077583	9.996874	9.080710	10.919290	8
53	9.078631	9.996858	9.081773	10.918227	7
54	9.079676	9.996843	9.082833	10.917167	6
55	9.080719	9.996828	9.083891	10.916109	5
56	9.081759	9.996812	9.084947	10.915053	4
57	9.082797	9.996797	9.085999	10.914100	3
58	9.083832	9.996782	9.087050	10.912950	2
59	9.084864	9.996766	9.088098	10.911902	1
60	9.085894	9.996751	9.089144	10.910856	0
	Co-sine	Sine	Co-tang.	Tangent	M

Degree 83.

M	Sine	Co-sine	Tangent	Co-tang.	
0	9.085894	9.996751	9.089144	10.910856	60
1	9.086922	9.996735	9.090187	10.909813	59
2	9.087947	9.996720	9.091228	10.908772	58
3	9.088970	9.996704	9.092266	10.907734	57
4	9.089990	9.996688	9.093302	10.906698	56
5	9.091088	9.996673	9.094336	10.905664	55
6	9.092024	9.996657	9.095367	10.904633	54
7	9.093037	9.996641	9.096395	10.903604	53
8	9.094047	9.996625	9.097422	10.902578	52
9	9.095056	9.996610	9.098446	10.901554	51
10	9.096062	9.996594	9.099468	10.900532	50
11	9.097065	9.996578	9.100487	10.899513	49
12	9.098066	9.996562	9.101504	10.898496	48
13	9.099065	9.996546	9.102519	10.897481	47
14	9.100062	9.996530	9.103532	10.896468	46
15	9.101056	9.996514	9.104542	10.895458	45
16	9.102048	9.996498	9.105550	10.894450	44
17	9.103037	9.996482	9.106556	10.893444	43
18	9.104025	9.996465	9.107559	10.892441	42
19	9.105010	9.996449	9.108560	10.891440	41
20	9.105992	9.996433	9.109559	10.890441	40
21	9.106973	9.996417	9.110556	10.889444	39
22	9.107951	9.996400	9.111551	10.888449	38
23	9.108927	9.996384	9.112543	10.887457	37
24	9.109901	9.996368	9.113533	10.886467	36
25	9.110873	9.996351	9.114521	10.885478	35
26	9.111842	9.996335	9.115507	10.884493	34
27	9.112809	9.996318	9.116491	10.883509	33
28	9.113774	9.996302	9.117472	10.882528	32
29	9.114737	9.996285	9.118452	10.881548	31
30	9.115698	9.996269	9.119429	10.880571	30
	Co sine	Sine	Co-tang.	Tangent	M

M	Sine	Co-sine	Tangent	Co-tang.	
30	9.115698	9.996269	9.119429	10.880571	30
31	9.116656	9.996252	9.120404	10.879596	29
32	9.117612	9.996235	9.121377	10.878623	28
33	9.118567	9.996218	9.122348	10.877652	27
34	9.119519	9.996202	9.123317	10.876683	26
35	9.120469	9.996185	9.124284	10.875716	25
36	9.121417	9.996168	9.125248	10.874751	24
37	9.122362	9.996151	9.126211	10.873789	23
38	9.123306	9.996134	9.127172	10.872828	22
39	9.124248	9.996117	9.128130	10.871870	21
40	9.125187	9.996100	9.129087	10.870913	20
41	9.126125	9.996083	9.130041	10.869959	19
42	9.127060	9.996066	9.130994	10.869006	18
43	9.127993	9.996049	9.131944	10.868056	17
44	9.128925	9.996032	9.132893	10.867107	16
45	9.129854	9.996015	9.133839	10.869161	15
46	9.130781	9.995998	9.134784	10.865216	14
47	9.131706	9.995980	9.135726	10.864274	13
48	9.132630	9.995963	9.136666	10.863334	12
49	9.133551	9.995946	9.137605	10.862395	11
50	9.134470	9.995928	9.138542	10.861458	10
51	9.135387	9.995911	9.139476	10.860524	9
52	9.136303	9.995894	9.140409	10.859591	8
53	9.137216	9.995876	9.141340	10.858660	7
54	9.138127	9.995859	9.142269	10.857731	6
55	9.139037	9.995841	9.143196	10.856804	5
56	9.139944	9.995825	9.144121	10.855879	4
57	9.140850	9.995806	9.145044	10.854956	3
58	9.141754	9.995788	9.145965	10.854035	2
59	9.142655	9.995770	9.146885	10.853115	1
60	9.142555	9.995753	9.147803	10.852197	0
	Co-sine	Sine	Co-tang.	Tangent	M

M	Sine	Co-sine	Tangent	Co-tang.	
0	9.143555	9.995753	9.147803	10.852197	60
1	9.144453	9.995735	9.148718	10.851282	59
2	9.145349	9.995717	9.149632	10.850368	58
3	9.146243	9.995699	9.150544	10.849456	57
4	9.147136	9.995681	9.151454	10.848546	56
5	9.148026	9.995664	9.152363	10.847637	55
6	9.148919	9.995646	9.153269	10.846731	54
7	9.149881	9.995628	9.154174	10.845825	53
8	9.150686	9.995610	9.155077	10.844923	52
9	9.151569	9.995591	9.155978	10.844022	51
10	9.152451	9.995573	9.156877	10.843123	50
11	9.153330	9.995555	9.157775	10.842225	49
12	9.154208	9.995537	9.158671	10.841329	48
13	9.155082	9.995519	9.159565	10.840435	47
14	9.155957	9.995501	9.160457	10.839543	46
15	9.156830	9.995482	9.161347	10.838653	45
16	9.157700	9.995464	9.162236	10.837764	44
17	9.158569	9.995446	9.163123	10.836877	43
18	9.159436	9.995427	9.164008	10.835992	42
19	9.160301	9.995409	9.164892	10.835108	41
20	9.161164	9.995390	9.165773	10.834226	40
21	9.162025	9.995372	9.166654	10.833346	39
22	9.162885	9.995353	9.167532	10.832468	38
23	9.163743	9.995334	9.168409	10.831591	37
24	9.164600	9.995316	9.169284	10.830716	36
25	9.165454	9.995297	9.160157	10.829843	35
26	9.166307	9.995278	9.171029	10.828971	34
27	9.167158	9.995260	9.171899	10.828101	33
28	9.168008	9.995241	9.172767	10.827233	32
29	9.168856	9.995222	9.173634	10.826366	31
30	9.169702	9.995203	9.174499	10.825501	30
	Co-sine	Sine	Co-tang.	Tangent	M

90

M	Sine	*Co-fine*	Tangent	*Co-tang.*	
30	9.169702	9.995203	9.174499	10.825501	30
31	9.170546	9.995184	9.175362	10.824638	29
32	9.171389	9.995165	9.176224	10.823776	28
33	9.172230	9.995146	9.177084	10.822916	27
34	9.173070	9.995127	9.177942	10.822057	26
35	9.173908	9.995108	9.178799	10.821201	25
36	9.174744	9.995089	9.179655	10.820345	24
37	9.175578	9.995070	9.180508	10.819492	23
38	9.176411	9.995061	9.181360	10.818640	22
39	9.177242	9.995032	9.182211	10.817789	21
40	9.178072	9.995012	9.183060	10.816940	20
41	9.178900	9.994993	9.183907	10.816093	19
42	9.179726	9.994974	9.184752	10.815248	18
43	9.180551	9.994955	9.185597	10.814403	17
44	9.181374	9.994935	9.186439	10.813561	16
45	9.182196	9.994916	9.187280	10.812720	15
46	9.183016	9.994896	9.188120	10.811880	14
47	9.183834	9.994876	9.188957	10.811042	13
48	9.184651	9.994857	9.189794	10.810206	12
49	9.185466	9.994838	9.190629	10.809371	11
50	9.186280	9.994818	9.191462	10.808538	10
51	9.187092	9.994798	9.192294	10.807706	9
52	9.187903	9.994779	9.193124	10.806876	8
53	9.188712	9.994759	9.193953	10.806047	7
54	9.189519	9.994739	9.194780	10.805220	6
55	9.190325	9.994719	9.195606	10.804394	5
56	9.191130	9.994699	9.196440	10.803569	4
57	9.191933	9.994680	9.197253	10.802747	3
58	9.192734	9.994660	9.198674	10.801926	2
59	9.193534	9.994640	9.198894	10.801106	1
60	9.194332	9.994620	9.199712	10.800287	0
	Co-fine	Sine	*Co-tang.*	Tangent	M

Degree 81.

436 Degree 9.

M	Sine	Co-sine	Tangent	Co-tang.	
0	9.194332	9.994620	9.199712	10.800287	60
1	9.195129	9.994600	9.200529	10.799470	59
2	9.195925	9.994580	9.201345	10.798655	58
3	9.196718	9.994560	9.202159	10.797841	57
4	9.197511	9.994540	9.202971	10.797029	56
5	9.198302	9.994519	9.203782	10.796218	55
6	9.199091	9.994499	9.204592	10.795408	54
7	9.199879	9.994479	9.205400	10.794600	53
8	9.200666	9.994459	9.206207	10.793793	52
9	9.201451	9.994438	9.207013	10.792987	51
10	9.202234	9.994418	9.207817	10.792183	50
11	9.203017	9.994398	9.208619	10.791381	49
12	9 203797	9.994377	9.209420	10.790580	48
13	9.204577	9.994357	9.210220	10.789780	47
14	9.205354	9.994336	9.211018	10.788982	46
15	9.206131	9.994316	9.211815	10.788185	45
16	9.206906	9.994195	9.212611	10.787385	44
17	9.207679	9.994174	9.213405	10.786595	43
18	9.208452	9.994154	9.214198	10.785802	42
19	9.209222	9.994133	9.214989	10.785011	41
20	9.209992	9.994112	9.215780	10.784220	40
21	9.210760	9.994191	9.216568	10.783432	39
22	9.211526	9.994171	9.217356	10.782644	38
23	9.212291	9.994150	9.218142	10.781858	37
24	9.213055	9.994129	9.218926	10.781070	36
25	9.213818	9.994108	9.219710	10.780294	35
26	9.214579	9.994087	9.220491	10.779508	34
27	9.215338	9.994066	9.221272	10.778728	33
28	9.216097	9.994044	9.222052	10.777948	32
29	9.216854	9.994024	9.222830	10.777170	31
30	9.217609	9.994003	9.223607	10.776393	30
	Co-sine	Sine	Co-tang.	Tangent	M

Degree 80.

Degree 9. 437

M	Sine	Co-sine	Tangent	Co-tang.	
30	9.217609	9.994003	9.223607	10.716393	30
31	9.218363	9.993982	9.224382	10.775618	29
32	9.219116	9.993960	9.225156	10.774844	28
33	9.219868	9.993939	9.225929	10.774071	27
34	9.220618	9.993918	9.226704	10.773300	26
35	9.221367	9.993897	9.227471	10.772529	25
36	9.222115	9.993875	9.228240	10.771760	24
37	9.222861	9.993854	9.229007	10.770993	23
38	9.223606	9.993832	9.229774	10.770226	22
39	9.224349	9.993811	9.230539	10.769461	21
40	9.225092	9.993789	9.231302	10.768698	20
41	9.225833	9.993768	9.232065	10.767935	19
42	9.226573	9.993746	9.232826	10.767174	18
43	9.227311	9.993725	9.233586	10.766414	17
44	9.228048	9.993703	9.234345	10.765655	16
45	9.228784	9.993681	9.235103	10.764897	15
46	9.239518	9.993660	9.235859	10.764141	14
47	9.230252	9.993638	9.236614	10.763386	13
48	9.230984	9.993616	9.237368	10.762632	12
49	9.231715	9.993594	9.238120	10.761880	11
50	9.232444	9.993572	9.238872	10.761128	10
51	9.233172	9.993550	9.239622	10.760378	9
52	9.233899	9.993528	9.240371	10.759629	8
53	9.234625	9.993506	9.241118	10.758882	7
54	9.235349	9.993484	9.241865	10.758135	6
55	9.236073	9.993462	9.242610	10.757390	5
56	9.236795	9.993440	9.243354	10.756646	4
57	9.237515	9.993418	9.244097	10.755903	3
58	9.238835	9.993396	9.244839	10.755161	2
59	9.238952	9.993374	9.245579	10.754421	1
60	9.239670	9.993351	9.246319	10.753681	0
	Co-sine	Sine	Co-tang.	Tangent	M

Degree 80.

M	Sine	Co-sine	Tangent	Co-tang.	
0	9.239670	9.993351	9.246319	10.753681	60
1	9.240386	9.993329	9.247057	10.752943	59
2	9.241101	9.993307	9.247794	10.752206	58
3	9.241814	9.993284	9.248530	10.751470	57
4	9.242526	9.993262	9.249264	10.750736	56
5	9.243237	9.993240	9.249998	10.750002	55
6	9.243947	9.993117	9.250730	10.749270	54
7	9.244656	9.993195	9.251461	10.748539	53
8	9.245363	9.993172	9.252191	10.747809	52
9	9.246070	9.993149	9.252920	10.747080	51
10	9.246775	9.993127	9.253648	10.746352	50
11	9.247478	9.993104	9.254374	10.745626	49
12	9.248181	9.993011	9.255200	10.744900	48
13	9.248883	9.993059	9.255824	10.744176	47
14	9.249583	9.993036	9.256547	10.743453	46
15	9.250282	9.993013	9.257269	10.742731	45
16	9.250980	9.992990	9.257990	10.742010	44
17	9.251677	9.992967	9.258710	10.741290	43
18	9.252373	9.992944	9.259429	10.740571	42
19	9.253067	9.992921	9.260146	10.739854	41
20	9.253761	9.992898	9.260863	10.739137	40
21	9.254453	9.992875	9.261578	10.738422	39
22	9.255144	9.992852	9.262292	10.737708	38
23	9.255834	9.992829	9.263005	10.736995	37
24	9.256523	9.992806	9.263717	10.736283	36
25	9.257211	9.992783	9.264428	10.735572	35
26	9.257898	9.992759	9.265138	10.734862	34
27	9.258583	9.992736	9.265847	10.734153	33
28	9.259268	9.992713	9.266555	10.733445	32
29	9.259951	9.992690	9.267261	10.732739	31
30	9.260633	9.992666	9.267967	10.732033	30
	Co-sine	Sine	Co-tang.	Tangent	M

Degree 79.

439 Degree 10.

M	Sine	*Co-fine*	Tangent.	*Co-tang.*	
30	9.260633	9.992666	9.267967	10.732033	30
31	9.261314	9.992643	9.268671	10.731329	29
32	9.261994	9.992619	9.269375	10.730625	28
33	9.262673	9.992596	9.270778	10.729923	27
34	9.263351	9.992572	9.271479	10.729221	26
35	9.264027	9.992549	9.271479	10.728521	25
36	9.264703	9.992525	9.272178	10.727822	24
37	9.265378	9.992501	9.272876	10.727124	23
38	9.266051	9.992478	9.273573	10.726427	22
39	9.266723	9.992454	9.274269	10.725731	21
40	9.267395	9.992430	9.274964	10.725036	20
41	9.268065	9.992406	9.275658	10.724342	19
42	9.268734	9.992382	9.276351	10.723649	18
43	9.269402	9.992362	9.277043	10.722957	17
44	9.270069	9.992335	9.277734	10.722267	16
45	9.270735	9.992311	9.278424	10.721576	15
46	9.271400	9.992287	9.279113	10.720887	14
47	9.272063	9.992263	9.279801	10.720199	13
48	9.272726	9.992239	9.280488	10.719512	12
49	9.273388	9.992214	9.281174	10.718826	11
50	9.274049	9.992190	9.281858	10.718142	10
51	9.274708	9.992166	9.282542	10.717458	9
52	9.275367	9.992142	9.283225	10.716775	8
53	9.276025	9.992118	9283907	10.716093	7
54	9.276681	9.992093	9.284588	10.715412	6
55	9.277337	9.992069	9.285268	10.714732	5
56	9.277991	9.992045	9.285946	10.714053	4
57	9.278685	9.992020	9.286624	10.713376	3
58	9.279297	9.991996	9.287301	10.712699	2
59	9.279948	9.991971	9.287977	10.712023	1
60	9.280599	9.991947	9.288652	10.711348	0
	Co-fine	Sine	*Co-tang.*	Tangent	M

Degree 79.

M	Sine	Co-sine	Tangent	Co-tang.	
0	9.280599	9.991947	9.288652	10.711348	60
1	9.281229	9.991922	9.289326	10.710674	59
2	9.281897	9.991897	9.289999	10.710001	58
3	9.282544	9.991873	9.290671	10.709329	57
4	9.283190	9.991848	9.291342	10.708658	56
5	9.283836	9.991823	9.292013	10.707987	55
6	9.284480	9.991799	9.292682	10.707318	54
7	9.285124	9.991774	9.293350	10.706650	53
8	9.285766	9.991749	9.294017	10.705983	52
9	9.286408	9.991724	9.294684	10.705316	51
10	9.287048	9.991699	9.295349	10.704651	50
11	9.287688	9.991674	9.296013	10.703987	49
12	9.288326	9.991649	9.296677	10.703323	48
13	9.288964	9.991624	9.297339	10.702661	47
14	9.289600	9.991599	9.298001	10.701999	46
15	9.290236	9.991574	9.298662	10.701338	45
16	9.290870	9.991549	9.299322	10.700678	44
17	9.291504	9.991524	9.299980	10.700020	43
18	9.292137	9.991498	9.300638	10.699362	42
19	9.292768	9.991473	9.301295	10.698705	41
20	9.293399	9.991448	9.301951	10.698049	40
21	9.294029	9.991422	9.302607	10.697393	39
22	9.294658	9.991397	9.303261	10.696739	38
23	9.295286	9.991372	9.303914	10.696086	37
24	9.295913	9.991346	9.304567	10.695433	36
25	9.296539	9.991321	9.305218	10.694782	35
26	9.297164	9.991295	9.305867	10.694131	34
27	9.297788	9.991270	9.306519	10.693481	33
28	9.298412	9.991244	9.307168	10.692832	32
29	9.299034	9.991218	9.307816	10.692184	31
30	9.299655	9.991193	9.308463	10.691537	30
	Co-sine	Sine	Co-tang.	Tangent	M

M	Sine	Co-sine	Tangent	Co-tang.	
30	9.299655	9.991193	9.308463	10.691537	30
31	9.300276	9.991167	9.309109	10.690891	29
32	9.300895	9.991141	9.309754	10.690246	28
33	9.301514	9.991115	9.310399	10.689601	27
34	9.302132	9.991090	9.311042	10.688958	26
35	9.302749	9.991064	9.311685	10.688315	25
36	9.303364	9.991038	9.312327	10.687673	24
37	9.303979	9.991012	9.312968	10.687032	23
38	9.304593	9.990986	9.313608	10.686392	22
39	9.305207	9.990960	9.314247	10.685753	21
40	9.305819	9.990934	9.314885	10.685115	20
41	9.306430	9.990908	9.315523	10.684477	19
42	9.307041	9.990882	9.316159	10.683841	18
43	9.307650	9.990855	9.316795	10.683205	17
44	9.308259	9.990829	9.317430	10.682570	16
45	9.308867	9.990803	9.318064	10.681936	15
46	9.309474	9.990777	9.318647	10.681303	14
47	9.310080	9.990750	9.319330	10.680670	13
48	9.310685	9.990724	9.319961	10.680039	12
49	9.311289	9.990697	9.320592	10.679408	11
50	9.311899	9.990671	9.321222	10.678778	10
51	9.312495	9.990645	9.321851	10.678149	9
52	9.313097	9.990618	9.322479	10.677521	8
53	9.313698	9.990591	9.323106	10.676894	7
54	9.314297	9.990565	9.323733	10.676267	6
55	9.314897	9.990538	9.324358	10.675642	5
56	9.315495	9.990512	9.324983	10.675017	4
57	9.316092	9.990485	9.325607	10.674393	3
58	9.316689	9.990458	9.326231	10.673769	2
59	9.317284	9.990431	9.326853	10.673147	1
60	9.317879	9.990404	9.327475	10.672525	0
	Co-sine.	Sine	Co-tang.	Tangent	M

M	Sine	Co-sine	Tangent	Co-tang.	
0	9.317879	9.990404	9.327475	10.672525	60
1	9.318473	9.990377	9.328095	10.671905	59
2	9.319066	9.990351	9.328715	10.671285	58
3	9.319658	9.990324	9.329834	10.670666	57
4	9.320250	9.990297	9.329953	10.670047	56
5	9.320840	9.990270	9.320570	10.669430	55
6	9.321430	9.990242	9.331187	10.668813	54
7	9.322019	9.990215	9.331803	10.668197	53
8	9.322607	9.990188	9.332418	10.667582	52
9	9.323194	9.990161	9.333033	10.666967	51
10	9.323780	9.990134	9.333646	10.666354	50
11	9.324366	9.990107	9.334259	10.665741	49
12	9.324950	9.990079	9.334871	10.665129	48
13	9.325534	9.990052	9.335482	10.664518	47
14	9.326117	9.990025	9.336093	10.663907	46
15	9.326699	9.989997	9.336700	10.663298	45
16	9.327281	9.989970	9.337311	10.662689	44
17	9.327862	9.989942	9.337919	10.662081	43
18	9.328441	9.989915	9.338527	10.661473	42
19	9.329020	9.989887	9.339133	10.660867	41
20	9.329599	9.989860	9.339739	10.660261	40
21	9.330176	9.989832	9.340344	10.659656	39
22	9.330753	9.989804	9.340948	10.659052	38
23	9.331328	9.989777	9.341552	10.658448	37
24	9.331903	9.989749	9.342155	10.657845	36
25	9.332478	9.989721	9.342757	10.657243	35
26	9.333051	9.989693	9.343358	10.656642	34
27	9.333624	9.989665	9.343958	10.656042	33
28	9.334195	9.989637	9.344558	10.655442	32
29	9.334766	9.989609	9.345157	10.654843	31
30	9.335337	9.989581	9.345755	10.654245	30
	Co-sine	Sine	Co-tang.	Tangent.	M

M	Sine	*Co-fine*	Tangent	*Co-tang.*	
30	9.335337	9.989581	9.345755	10.654245	30
31	9.335906	9.989553	9.346353	10.653647	29
32	9.336475	9.989525	9.346949	10.653051	28
33	9.337043	9.989597	9.347545	10.652455	27
34	9.337610	9.989469	9.348141	10.651859	26
35	9.338176	9.989441	9.348735	10.651265	25
36	9.338742	9.989413	9.349329	10.650671	24
37	9.339306	9.989384	9.349922	10.650078	23
38	9.339870	9.989356	9.350514	10.649486	22
39	9.340434	9.989328	9.351106	10.648894	21
40	9.340996	9.989299	9.351697	10.648303	20
41	9.341558	9.989271	9.352287	10.647713	19
42	9.342119	9.989243	9.352876	10.647124	18
43	9.342679	9.989214	9.353465	10.646535	17
44	9.343239	9.989186	9.354053	10.645947	16
45	9.343797	9.989157	9.354640	10.645360	15
46	9.344355	9.989128	9.355227	10.644773	14
47	9.344912	9.989100	9.355812	10.644187	13
48	9.345469	9.989071	9.356398	10.643602	12
49	9.346024	9.989042	9.356982	10.643018	11
50	9.346579	9.989014	9.357566	10.642434	10
51	9.347134	9.988985	9.358149	10.641851	9
52	9.347687	9.988956	9.358731	10.641269	8
53	9.348240	9.988927	9.359313	10.640687	7
54	9.348792	9.988898	9.359893	10.640107	6
55	9.349343	9.988869	9.360474	10.639526	5
56	9.349893	9.988840	9.361053	10.638947	4
57	9.350443	9.988811	9.361632	10.638368	3
58	9.350992	9.988782	9.362210	10.637790	2
59	9.351540	9.988754	9.362787	10.637213	1
60	9.352088	9.988724	9.363364	10.636636	0
	Co-fine.	Sine	*Co-tang.*	Tangent.	M

Degree 77.

M	Sine	*Co-fine*	Tangent	*Co-tang.*	
0	9.352088	9.988724	9.363364	10.636636	60
1	9.352635	9.988695	9.363940	10.636060	59
2	9.353181	9.988666	9.364515	10.635485	58
3	9.353726	9.988636	9.365090	10.634910	57
4	9.354271	9.988607	9.365664	10.634336	56
5	9.354815	9.988578	9.366237	10.633763	55
6	9.355358	9.988548	9.366810	10.633190	54
7	9.355901	9.988519	9.367382	10.632618	53
8	9.356443	9.988489	9.367953	10.632047	52
9	9.356984	9.988460	9.368524	10.631476	51
10	9.357524	9.988430	9.369094	10.630906	50
11	9.358064	9.988401	9.369663	10.630337	49
12	9.358603	9.988371	9.370232	10.629768	48
13	9.359141	9.988341	9.370799	10.629201	47
14	9.359679	9.988312	9.371367	10.628633	46
15	9.360215	9.988282	9.371933	10.628067	45
16	9.360752	9.988252	9.372499	10.627501	44
17	9.361287	9.988223	9.373064	10.626936	43
18	9.361822	9.988193	9.373629	10.626371	42
19	9.362356	9.988163	9.374193	10.625807	41
20	9.362889	9.988133	9.374756	10.625244	40
21	9.363422	9.988103	9.375319	10.624681	39
22	9.363954	9.988073	9.375881	10.624119	38
23	9.364485	9.988043	9.376442	10.623558	37
24	9.365016	9.988013	9.377003	10.622997	36
25	9.365546	9.987983	9.377563	10.622437	35
26	9.366075	9.987953	9.378122	10.621878	34
27	9.366604	9.987922	9.378681	10.621319	33
28	9.367132	9.987892	9.379239	10.620761	32
29	9.367659	9.987862	9.379797	10.620203	31
30	9.368185	9.987832	9.380354	10.619646	30
	Co-fine	Sine	*Co-tang.*	Tangent	M

M	Sine	Co-sine	Tangent	Co-tang.	
30	9.368185	9.987832	9.380354	10.619646	30
31	9.368711	9.987801	9.380910	10.619090	29
32	9.369236	9.987771	9.381466	10.618534	28
33	9.369761	9.987740	9.382021	10.617980	27
34	9.370285	9.987710	9.382575	10.617425	26
35	9.370808	9.987679	9.383129	10.616871	25
36	9.371330	9.987649	9.383682	10.616318	24
37	9.371852	9.987618	9.384234	10.615766	23
38	9.372373	9.987588	9.384786	10.615214	22
39	9.372894	9.987557	9.385337	10.614663	21
40	9.373414	9.987526	9.385888	10.614112	20
41	9.373933	9.987496	9.386438	10.613562	19
42	9.374452	9.987465	9.386987	10.613013	18
43	9.374970	9.987434	9.387536	10.612464	17
44	9.375487	9.987403	9.388084	10.611916	16
45	9.376003	9.987372	9.388631	10.611369	15
46	9.376519	9.987341	9.389178	10.610822	14
47	9.377035	9.987310	9.389724	10.610276	13
48	9.377549	9.987279	9.390270	10.609730	12
49	9.378063	9.987248	9.390815	10.609185	11
50	9.378577	9.987217	9.391360	10.608640	10
51	9.379089	9.987186	9.391907	10.608097	9
52	9.379601	9.987155	9.392467	10.607553	8
53	9.380113	9.987124	9.392989	10.607011	7
54	9.380624	9.987092	9.393531	10.606469	6
55	9.381134	9.987061	9.394074	10.605927	5
56	9.381643	9.987030	9.394614	10.605386	4
57	9.382152	9.986998	9.395154	10.604846	3
58	9.382661	9.986967	9.395694	10.604306	2
59	9.383168	9.986936	9.396233	10.603767	1
60	9.383675	9.986904	9.396770	10.603229	0
	Co-sine	Sine	Co-tang.	Tangent	M

Degree 76.

M	Sine	Co-sine	Tangent	Co-tang.	
00	9.383675	9.986904	9.396771	10.603229	60
1	9.384181	9.986873	9.397309	10.602694	59
2	9.384687	9.986841	9.397846	10.602154	58
3	9.385192	9.986809	9.398383	10.601617	57
4	9.385697	9.986778	9.398919	10.601081	56
5	9.386201	9.986746	9.399455	10.600545	55
6	9.386704	9.986714	9.399990	10.600010	54
7	9.387207	9.986683	9.400524	10.599476	53
8	9.387709	9.986651	9.401058	10.598942	52
9	9.388210	9.986619	9.401591	10.598409	51
10	9.388711	9.986587	9.402124	10.597876	50
11	9.389211	9.986555	9.402656	10.597344	49
12	9.389711	9.986523	9.403187	10.596813	48
13	9.390210	9.986491	9.403718	10.596282	47
14	9.390708	9.986459	9.404249	10.595751	46
15	9.391206	9.986427	9.404778	10.595222	45
16	9.391703	9.986395	9.405306	10.594692	44
17	9.392199	9.986363	9.405836	10.594164	43
18	9.392695	9.986331	9.406364	10.593636	42
19	9.393190	9.986299	9.406892	10.593608	41
20	9.393685	9.986266	9.407419	10.592581	40
21	9.394179	9.986234	9.407945	10.592055	39
22	9.394673	9.986201	9.408471	10.591529	38
23	9.395166	9.986869	9.408996	10.591001	37
24	9.395654	9.986137	9.409521	10.590479	36
25	9.396150	9.986104	9.410045	10.589954	35
26	9.396641	9.986072	9.410569	10.589431	34
27	9.397131	9.986039	9.411097	10.588908	33
28	9.397621	9.986007	9.411615	10.588385	32
29	9.398111	9.985974	9.412137	10.587863	31
30	9.398600	9.986942	9.412658	10.587342	30
	Co-sine	Sine	Co-tang.	Tangent	M

M	Sine	*Co-fine*	Tangent	*Co-tang.*	
30	9.398600	9.985942	9.412658	10.587342	30
31	9.399087	9.985909	9.413179	10.586821	29
32	9.399575	9.985876	9.413699	10.586301	28
33	9.400062	9.985843	9.414219	10.585781	27
34	9.400549	9.985811	9.414738	10.585262	26
35	9.401035	9.985778	9.415257	10.584742	25
36	9.401520	9.985745	9.415775	10.584225	24
37	9.402005	9.985712	9.416293	10.583707	23
38	9.402489	9.985679	9.416810	10.583190	22
39	9.402972	9.985646	9.417326	10.582674	21
40	9.403455	9.985613	9.417842	10.582157	20
41	9.403938	9.985580	9.418357	10 581642	19
42	9.404420	9.985547	9.418873	10.581127	18
43	9.404901	9.985513	9.419387	10 580613	17
44	9.405382	9.985480	9.419901	10.580099	16
45	9.405862	9.985447	9.420415	10.579585	15
46	9.406341	9.985414	9.420927	10.579072	14
47	9.406820	9.985380	9.421440	10.578560	13
48	9.407299	9.985347	9.421951	10.578048	12
49	9.407776	9.985314	9.422463	10.577537	11
50	9.408254	9.985280	9.422973	10.577026	10
51	9.408731	9.985247	9.423484	10.576516	9
52	9.409207	9.985213	9.423993	10.576007	8
53	9.409682	9.985180	9.424503	10.575497	7
54	9.410157	9.985146	9.425011	10.574989	6
55	9.410632	9.985112	9.425518	10.574480	5
56	9.411106	9.985079	9.426027	10.573973	4
57	9.411579	9.985045	9.426534	10.573466	3
58	9.412052	9.985011	9.427041	10.572959	2
59	9.412524	9.984977	9.427547	10.572453	1
60	9.412996	9.984943	9.428052	10.571947	0
	Co-fine	Sine	*Co-tang.*	Tangent	M

M	Sine	Co-fine	Tangent	Co-tang.	
0	9.412996	9.984944	9.428052	10.571947	60
1	9.413467	9.984910	9.428557	10.571442	59
2	9.413938	9.984876	9.429067	10.570938	58
3	9.414408	9.984842	9.429566	10.570434	57
4	9.414878	9.984808	9.430070	10.569930	56
5	9.415347	9.984774	9.430573	10.569427	55
6	9.415815	9.984740	9.431075	10.568925	54
7	9.416283	9.984706	9.431577	10.568423	53
8	9.416850	9.984672	9.432079	10.567921	52
9	9.417217	9.984637	9.432580	10.567420	51
10	9.417684	9.984603	9.433080	10.566920	50
11	9.418149	9.984569	9.433580	10.566419	49
12	9.418615	9.984535	9.434080	10.565920	48
13	9.419079	9.984500	9.434579	10.565421	47
14	9.419544	9.984466	9.435078	10.564922	46
15	9.420007	9.984431	9.435576	10.564424	45
16	9.420470	9.984397	9.436073	10.563927	44
17	9.420933	9.984363	9.436570	10.563430	43
18	9.421395	9.984328	9.437067	10.562933	42
19	9.421856	9.984293	9.437563	10.562437	41
20	9.422317	9.984259	9.438059	10.561941	40
21	9.422778	9.984224	9.438554	10.561446	39
22	9.423238	9.984189	9.439548	10.560952	38
23	9.423697	9.984155	9.439543	10.560457	37
24	9.424156	9.984120	9.440036	10.559964	36
25	9.424615	9.984085	9.440529	10.559471	35
26	9.425072	9.984050	9.441022	10.558978	34
27	9.425530	9.984015	9.441514	10.558486	33
28	9.425987	9.983980	9.442006	10.557994	32
29	9.426443	9.983945	9.442497	10.557503	31
30	9.426899	9.983910	9.442988	10.557011	30
	Co-fine	Sine	Co-tang.	Tangent	M

M	Sine	Co-sine	Tangent	Co-tang.	
30	9.426899	9.983910	9.442988	10.557011	30
31	9.427354	9.983875	9.443479	10.556521	29
32	9.427809	9.983840	9.443968	10.556031	28
33	9.428264	9.983805	9.444458	10.555542	27
34	9.428717	9.983770	9.444947	10.555035	26
35	9.429170	9.983735	9.445435	10.554565	25
36	9.429623	9.983699	9.445923	10.554077	24
37	9.430075	9.983664	9.446411	10.553589	23
38	9.430507	9.983629	9.446898	10.553102	22
39	9.430978	9.983593	9.447384	10.552616	21
40	9.431429	9.983558	9.447870	10.552129	20
41	9.431879	9.983523	9.448356	10.551644	19
42	9.432328	9.983487	9.448841	10.551159	18
43	9.432778	9.983452	9.449326	10.550674	17
44	9.433206	9.983416	9.449810	10.550181	16
45	9.433674	9.983380	9.450294	10.559706	15
46	9.434122	9.983345	9.450777	10.549223	14
47	9.434569	9.983309	9.451260	10.548740	13
48	9.435016	9.983273	9.451743	10.548257	12
49	9.435462	9.983238	9.452225	10.547775	11
50	9.435918	9.983202	9.452706	10.547294	10
51	9.436353	9.983166	9.453187	10.546813	9
52	9.436798	9.983130	9.453668	10.546332	8
53	9.437242	9.983094	9.454148	10.545852	7
54	9.437686	9.983058	9.454629	10.545372	6
55	9.438129	9.983022	9.455107	10.544893	5
56	9.438572	9.982986	9.455586	10.544414	4
57	9.439014	9.982950	9.456064	10.543936	3
58	9.439456	9.982914	9.456542	10.543458	2
59	9.439897	9.982878	9.457019	10.542980	1
60	9.440338	9.982842	9.457496	10.542503	0
	Co-sine	Sine	Co-tang.	Tangent	M

M	Sine	Co-fine	Tangent	Co-tang.	
0	9.440338	9.982842	9.457496	10.542503	60
1	9.440778	9.982805	9.457973	10.542027	59
2	9.441218	9.982769	9.458449	10.541551	58
3	9.441658	9.982733	9.458925	10.541075	57
4	9.442096	9.982696	9.459400	10.540600	56
5	9.442535	9.982660	9.459875	10.540125	55
6	9.442973	9.982623	9.460349	10.539651	54
7	9.443416	9.982587	9.460829	10.539177	53
8	9.443848	9.982550	9.461297	10.538703	52
9	9.444284	9.982514	9.461770	10.538230	51
10	9.444720	9.982477	9.462242	10.537758	50
11	9.445155	9.982441	9.462714	10.537285	49
12	9.445590	9.982404	9.463186	10.536814	48
13	9.446025	9.982367	9.463658	10.536342	47
14	9.446459	9.982330	9.464129	10.535871	46
15	9.446893	9.982294	9.464599	10.535401	45
16	9.447326	9.982257	9.465069	10.534931	44
17	9.447759	9.982220	9.465539	10.534461	43
18	9.448191	9.982183	9.466008	10.533992	42
19	9.448623	9.982146	9.466476	10.533523	41
20	9.449054	9.982109	9.466945	10.533055	40
21	9.449485	9.982072	9.467413	10.532587	39
22	9.449915	9.982035	9.467880	10.532120	38
23	9.450345	9.981998	9.468347	10.531653	37
24	9.450775	9.981961	9.468814	10.531186	36
25	9.451203	9.981923	9.469280	10.530720	35
26	9.451632	9.981886	9.469746	10.530254	34
27	9.452060	9.981849	9.470211	10.529789	33
28	9.452488	9.981812	9.470676	10.529324	32
29	9.452915	9.981774	9.471141	10.528859	31
30	9.453342	9.981737	9.471605	10.528395	30
	Co-fine	Sine	Co-tang.	Tangent	M

M	Sine	Co-sine	Tangent	Co-tang.	
30	9.453342	9.981737	9.471605	10.528395	30
31	9.453768	9.981699	9.472068	10.527931	29
32	9.454194	9.981662	9.472532	10.527468	28
33	9.454619	9.981624	9.472995	10.527005	27
34	9.455044	9.981587	9.473457	10.526543	26
35	9.455469	9.981549	9.473919	10.526081	25
36	9.455892	9.981512	9.474381	10.525619	24
37	9.456316	9.981474	9.474842	10.525158	23
38	9.456739	9.981436	9.475303	10.524695	22
39	9.457162	9.981398	9.475763	10.524237	21
40	9.457584	9.981361	9.476223	10.523777	20
41	9.458006	9.981323	9.476683	10.523317	19
42	9.458427	9.981285	9.477142	10.522858	18
43	9.458848	9.981247	9.477601	10.522399	17
44	9.459268	9.981209	9.478059	10.521941	16
45	9.459684	9.981171	9.478517	10.521483	15
46	9.460108	9.981133	9.478975	10.521025	14
47	9.460527	9.981095	9.479432	10.520168	13
48	9.460946	9.981057	9.479886	10.520111	12
49	9.461364	9.981019	9.480345	10.519655	11
50	9.461782	9.980980	9.480801	10.519199	10
51	9.462199	9.980942	9.481257	10.518743	9
52	9.462616	9.980904	9.481712	10.518288	8
53	9.463032	9.980866	9.482167	10.517833	7
54	9.463448	9.980827	9.482621	10.517379	6
55	9.463864	9.980789	9.483075	10.516925	5
56	9.464279	9.980750	9.483528	10.516471	4
57	9.464694	9.980712	9.483982	10.516018	3
58	9.465108	9.980672	9.484434	10.515565	2
59	9.465522	9.980635	9.484887	10.515113	1
60	9.465935	9.980596	9.485339	10.514661	0
	Co-sine	Sine	Co-tang.	Tangent	M

M	Sine	*Co-sine*	Tangent	*Co-tang.*	
0	9.465935	9.980596	9.485339	10.514661	60
1	9.466348	9.980558	9.485791	10.514209	59
2	9.466761	9.980519	9.486272	10.513758	58
3	9.467173	9.980480	9.486693	10.513307	57
4	9.467585	9.980441	9.487143	10.512857	56
5	9.467996	9.980403	9.487593	10.512407	55
6	9.468407	9.980364	9.488043	10.511957	54
7	9.468817	9.980325	9.488493	10.511507	53
8	9.469227	9.980286	9.488941	10.511059	52
9	9.469637	9.980247	9.489390	10.510610	51
10	9.460446	9.980208	9.489838	10.510162	50
11	9.470455	9.980169	9.490286	10.509714	49
12	9.471863	9.980130	9.490733	10.509267	48
13	9.471071	9.980091	9.491180	10.508820	47
14	9.471678	9.980052	9.491627	10.508373	46
15	9.472086	9.980012	9.492073	10.507928	45
16	9.472492	9.979973	9.492519	10.507481	44
17	9.472898	9.979934	9.492964	10.507035	43
18	9.473304	9.979894	9.493410	10.506590	42
19	9.473710	9.979855	9.493854	10.506145	41
20	9.474115	9.979816	9.494299	10.505701	40
21	9.474519	9.979776	9.494743	10.505257	39
22	9.474923	9.979737	9.495186	10.504813	38
23	9.475327	9.979697	9.495630	10.504370	37
24	9.475730	9.979658	9.496073	10.503928	36
25	9.476133	9.979618	9.496515	10.503485	35
26	9.476539	9.979578	9.496957	10.503043	34
27	9.476938	9.979539	9.497399	10.502601	33
28	9.477340	9.979499	9.497840	10.502160	32
29	9.477741	9.979459	9.498282	10.501718	31
30	9.478142	9.979419	9.498722	10.501278	30
	Co-sine	Sine	*Co-tang.*	Tangent	M

M	Sine	Co-sine	Tangent	Co-tang.	
30	9.478142	9.979419	9.498722	10.501278	30
31	9.478542	9.979380	9.499163	10.500837	29
32	9.478942	9.979340	9.499602	10.500398	28
33	9.479342	9.979300	9.500042	10.499958	27
34	9.479741	9.979260	9.500481	10.499519	26
35	9.480140	9.979220	9.500920	10.499080	25
36	9.480538	9.979180	9.501359	10.498641	24
37	9.480936	9.979140	9.501797	10.498203	23
38	9.481334	9.979099	9.502234	10.497765	22
39	9.481731	9.979059	9.502672	10.497328	21
40	9.482128	9.979019	9.503109	10.496891	20
41	9.482525	9.978980	9.503546	10.496454	19
42	9.482921	9.978937	9.503982	10.496018	18
43	9.483316	9.978898	9.504418	10.495582	17
44	9.483711	9.978858	9.504854	10.495146	16
45	9.484106	9.978817	9.505289	10.494711	15
46	9.484501	9.978777	9.505724	10.494216	14
47	9.484895	9.978736	9.506158	10.493841	13
48	9.485289	9.978696	9.506593	10.493407	12
49	9.485682	9.978655	9.507026	10.492973	11
50	9.486075	9.978615	9.507459	10.492540	10
51	9.486467	9.978574	9.507892	10.492107	9
52	9.486859	9.978533	9.508326	10.491674	8
53	9.487251	9.978493	9.508759	10.491241	7
54	9.487642	9.978452	9.509181	10.490809	6
55	9.488033	9.978411	9.509622	10.490377	5
56	9.488424	9.978370	9.510044	10.489946	4
57	9.488814	9.978329	9.510486	10.489515	3
58	9.489204	9.978288	9.510916	10.489084	2
59	9.489593	9.978247	9.511346	10.488654	1
60	9.489982	9.978206	9.511776	10.488225	0
	Co-sine	Sine	Co-tang.	Tangent	M

M	Sine	Co-sine	Tangent	Co-tang.	
0	9.489982	9.978206	9.511776	10.488224	60
1	9.490371	9.978165	9.512206	10.487794	59
2	9.490759	9.978124	9.512635	10.487365	58
3	9.491147	9.978083	9.513064	10.486936	57
4	9.491534	9.978042	9.513493	10.486507	56
5	9.491922	9.978000	9.513921	10.486079	55
6	9.492308	9.977959	9.514349	10.485651	54
7	9.492695	9.977918	9.514777	10.485223	53
8	9.493080	9.977877	9.515204	10.484796	52
9	9.493466	9.977835	9.515631	10.484369	51
10	9.493851	9.977794	9.516057	10.483942	50
11	9.494236	9.977752	9.516484	10.483516	49
12	9.494620	9.977711	9.516910	10.483090	48
13	9.495005	9.977669	9.517335	10.482665	47
14	9.495388	9.977628	9.517761	10.482239	46
15	9.495771	9.977586	9.518185	10.481814	45
16	9.496154	9.977544	9.518610	10.481390	44
17	9.496537	9.977503	9.519034	10.480966	43
18	9.496919	9.977461	9.519458	10.480542	42
19	9.497301	9.977419	9.519882	10.480118	41
20	9.497682	9.977377	9.520305	10.489695	40
21	9.498063	9.977335	9.520728	10.479272	39
22	9.498444	9.977293	9.521151	10.478849	38
23	9.498824	9.977251	9.521573	10.478427	37
24	9.499204	9.977209	9.521995	10.478005	36
25	9.499584	9.977167	9.522417	10.477583	35
26	9.499963	9.977125	9.522838	10.477162	34
27	9.500342	9.977083	9.523259	10.476741	33
28	9.500720	9.977041	9.523679	10.476320	32
29	9.501099	9.977999	9.524109	10.475900	31
30	9.501476	9.977956	9.524520	10.475480	30
	Co-sine	Sine	Co-tang.	Tangent	M

M	Sine	Co-sine	Tangent	Co-tang.	
30	9.501476	9.976956	9.524520	10.475480	30
31	9.501854	9.976914	9.524939	10.475060	29
32	9.502231	9.976872	9.525359	10.474641	28
33	9.502607	9.976830	9.525778	10.474222	27
34	9.502984	9.976787	9.526197	10.473803	26
35	9.503360	9.976745	9.526615	10.473385	25
36	9.503735	9.976702	9.527033	10.472967	24
37	9.504110	9.976660	9.527451	10.472549	23
38	9.504485	9.976617	9.527868	10.472132	22
39	9.504840	9.976574	9.528285	10.471715	21
40	9.505234	9.976532	9.528702	10.471298	20
41	9.505608	9.976489	9.529118	10.470881	19
42	9.505981	9.976446	9.529535	10.470465	18
43	9.506354	9.976404	9.529950	10.470049	17
44	9.506727	9.976361	9.530366	10.469634	16
45	9.507099	9.976318	9.530781	10.469219	15
46	9.507471	9.976275	9.531196	10.468804	14
47	9.507843	9.976232	9.531611	10.468389	13
48	9.508214	9.976185	9.532025	10.467975	12
49	9.508585	9.976146	9.532436	10.467561	11
50	9.508955	9.976103	9.532852	10.467147	10
51	9.509326	9.976060	9.533266	10.466734	9
52	9.509696	9.976017	9.533679	10.466321	8
53	9.510065	9.975973	9.534092	10.465908	7
54	9.510434	9.975930	9.534504	10.465496	6
55	9.510803	9.975887	9.534916	10.465084	5
56	9.511171	9.975844	9.535328	10.464672	4
57	9.511540	9.975800	9.535739	10.464261	3
58	9.511907	9.975757	9.536150	10.463849	2
59	9.512275	9.975713	9.536561	10.463439	1
60	9.512642	9.975670	9.536972	10.463028	0
	Co-sine	Sine	Co-tang.	Tangent	M

M	Sine	Co-sine	Tangent	Co-tang.	
0	9.512642	9.975670	9.536972	10.463028	60
1	9.513009	9.975626	9.537382	10.462618	59
2	9.513375	9.975583	9.537792	10.462208	58
3	9.513741	9.975539	9.538202	10.461798	57
4	9.514107	9.975496	9.538610	10.461389	56
5	9.514472	9.975452	9.539020	10.460980	55
6	9.514837	9.975408	9.539429	10.460571	54
7	9.515202	9.975364	9.539837	10.460163	53
8	9.515566	9.975321	9.540245	10.459755	52
9	9.515930	9.975277	9.540653	10.459347	51
10	9.516294	9.975233	9.541061	10.458939	50
11	9.516657	9.975189	9.541468	10.458532	49
12	9.517020	9.975145	9.541875	10.458125	48
13	9.517382	9.975101	9.542281	10.457719	47
14	9.517745	9.975057	9.542688	10.457312	46
15	9.518107	9.975013	9.543094	10.456906	45
16	9.518468	9.974969	9.543499	10.456501	44
17	9.518829	9.974925	9.543905	10.456095	43
18	9.519190	9.974880	9.544310	10.455690	42
19	9.519551	9.974836	9.544715	10.455285	41
20	9.519911	9.974792	9.545119	10.454881	40
21	9.520271	9.974747	9.545524	10.454476	39
22	9.520631	9.974703	9.545927	10.454072	38
23	9.520990	9.974659	9.546331	10.453669	37
24	9.521349	9.974614	9.546735	10.453265	36
25	9.521707	9.974570	9.547138	10.452862	35
26	9.522065	9.974525	9.547540	10.452459	34
27	9.522423	9.974480	9.547943	10.452057	33
28	9.522781	9.974436	9.548345	10.451655	32
29	9.523138	9.974391	9.548747	10.451253	31
30	9.523495	9.974346	9.549149	10.450851	30
	Co-sine	Sine	Co-tang.	Tangent	M

160

M	Sine	Co-sine	Tangent	Co-tang.	
30	9 523495	9.974346	9.549149	10.450851	30
31	9.523851	9.974302	9.549550	10.450450	29
32	9.524208	9.974257	9.549951	10.450049	28
33	9.524564	9.974212	9.550352	10.449648	27
34	9.524920	9.974167	9.550752	10.449248	26
35	9.525275	9.974122	9.551152	10.448848	25
36	9.525630	9.974077	9.551552	10.448448	24
37	9.525984	9.974032	9.551952	10.448048	23
38	9.526339	9.973987	9 552351	10.447649	22
39	9.526693	9.973942	9.552750	10.447250	21
40	9.527046	9.973897	9.553149	10.446851	20
41	9.527400	9.973852	9.553548	10.446452	19
42	9.527753	9.973807	9.553946	10.446054	18
43	9.528105	9.973761	9.554344	10.445656	17
44	9 528458	9.973716	9 554741	10.445259	16
45	9.528810	9.973671	9.555139	10.444861	15
46	9.529161	9.973615	9.555536	10.444464	14
47	9.529513	9.973580	9.555932	10.444068	13
48	9.529864	9.973535	9.556329	10.443671	12
49	9.530214	9 973489	9.556727	10.443275	11
50	9.530565	9.973443	9.557121	10.442879	10
51	9.530915	9.973398	9.557517	10.442483	9
52	9.531265	9.973352	9.557912	10.442088	8
53	9.531614	9.973307	9.558308	10.441693	7
54	9.531963	9.973261	9.558702	10.441298	6
55	9.532312	9.973215	9.559097	10.440903	5
56	9.532661	9.973169	9.559491	10.440509	4
57	9.533009	9.973123	9.559885	10.440115	3
58	9.533357	9.973078	9 560279	10.439721	2
59	9.533704	9 973032	9.560673	10.439327	1
60	9.534052	9.972986	9.561066	10.438934	0
	Co-sine.	Sine	Co-tang.	Tangent	M

109

M	Sine	Co-sine	Tangent	Co-tang.	
0	9.534052	9.972986	9.561066	10.438934	60
1	9.534399	9.972940	9.561459	10.438541	59
2	9.534746	9.972894	9.561851	10.438148	58
3	9.535091	9.972848	9.562244	10.437756	57
4	9.535437	9.972801	9.562636	10.437364	56
5	9.535782	9.972755	9.563028	10.436972	55
6	9.536129	9.972709	9.563419	10.436580	54
7	9.536474	9.972663	9.563811	10.436189	53
8	9.536818	9.972617	9.564202	10.435798	52
9	9.537163	9.972570	9.564592	10.435407	51
10	9.537507	9.972524	9.564983	10.435017	50
11	9.537851	9.972477	9.565373	10.434627	49
12	9.538194	9.972431	9.565763	10.434237	48
13	9.538537	9.972384	9.566153	10.433847	47
14	9.538880	9.972338	9.566542	10.433457	46
15	9.539222	9.972291	9.566932	10.433068	45
16	9.539565	9.972245	9.567320	10.432679	44
17	9.539907	9.972198	9.567709	10.432291	43
18	9.540249	9.972151	9.568097	10.431902	42
19	9.540590	9.972105	9.568486	10.431514	41
20	9.540931	9.972058	9.569873	10.431126	40
21	9.541272	9.972011	9.569261	10.430739	39
22	9.541612	9.971964	9.569648	10.430351	38
23	9.541953	9.971917	9.570035	10.429964	37
24	9.542292	9.971870	9.570422	10.429578	36
25	9.542632	9.971823	9.570809	10.429191	35
26	9.542971	9.971776	9.571195	10.428805	34
27	9.543310	9.971729	9.571581	10.428419	33
28	9.543649	9.971682	9.571967	10.428033	32
29	9.543987	9.971635	9.572352	10.427648	31
30	9.544325	9.971588	9.572738	10.427262	30
	Co-sine.	Sine	Co-tang.	Tangent	M

M	Sine	Co-fine	Tangent	Co-tang.	
30	9.544325	9.971588	9.572738	10.427262	30
31	9.544663	9.971540	9.573123	10.426877	29
32	9.545000	9.971493	9.573507	10.426492	28
33	9.545338	9.971446	9.573892	10.426108	27
34	9.545674	9.971398	9.574276	10.425724	26
35	9.546011	9.971351	9.574660	10.425340	25
36	9.546347	9.971303	9.575044	10.424956	24
37	9.546683	9.971256	9.575427	10.424573	23
38	9.547019	9.971208	9.575810	10.424189	22
39	9.547354	9.971161	9.576193	10.423807	21
40	9.547689	9.971112	9.576576	10.423424	20
41	9.548024	9.971065	9.576958	10.423041	19
42	9.548358	9.971018	9.577341	10.422659	18
43	9.548693	9.970970	9.577723	10.422277	17
44	9.549026	9.970922	9.578104	10.421896	16
45	9.549360	9.970874	9.578486	10.421514	15
46	9.549693	9.970826	9.578867	10.421133	14
47	9.550026	9.970779	9.579248	10.420752	13
48	9.550359	9.970731	9.579628	10.420371	12
49	9.550692	9.970683	9.580009	10.419991	11
50	9.551024	9.970634	9.580389	10.419611	10
51	9.551355	9.970586	9.580769	10.419231	9
52	9.551687	9.970538	9.581149	10.418851	8
53	9.552018	9.970490	9.581528	10.418472	7
54	9.552349	9.970442	9.581907	10.418092	6
55	9.552680	9.970394	9.582286	10.417713	5
56	9.553010	9.970345	9.582665	10.417335	4
57	9.553340	9.970297	9.583043	10.416956	3
58	9.553670	9.970249	9.583422	10.416578	2
59	9.554000	9.970200	9.583800	10.416200	1
60	9.554329	9.970152	9.584177	10.415823	0
	Co-fine	Sine	Co-tang.	Tangent	M

M	Sine	Co-sine	Tangent	Co-tang.	
0	9.554329	9.970152	9.584177	10.415822	60
1	9.554658	9.970103	9.584553	10.415445	59
2	9.554987	9.970055	9.584932	10.415068	58
3	9.555315	9.970006	9.585308	10.414691	57
4	9.555643	9.969957	9.585686	10.414314	56
5	9.555971	9.969909	9.586062	10.413938	55
6	9.556299	9.969860	9.586439	10.413561	54
7	9.556626	9.969811	9.586815	10.413185	53
8	9.556953	9.969762	9.587190	10.412800	52
9	9.557279	9.969713	9.587566	10.412434	51
10	9.557606	9.969665	9.587941	10.412059	50
11	9.557932	9.969616	9.588316	10.411684	49
12	9.558258	9.969567	9.588691	10.411309	48
13	9.558583	9.969518	9.589066	10.410934	47
14	9.558909	9.969469	9.589440	10.410560	46
15	9.559234	9.969419	9.589814	10.410185	45
16	9.559558	9.969370	9.590188	10.409812	44
17	9.559883	9.969321	9.590561	10.409438	43
18	9.560207	9.969272	9.590935	10.409065	42
19	9.560531	9.969223	9.591308	10.408692	41
20	9.560855	9.969173	9.591681	10.408319	40
21	9.561178	9.969124	9.592054	10.407946	39
22	9.561501	9.969075	9.592426	10.407574	38
23	9.561824	9.969025	9.592798	10.407201	37
24	9.562146	9.968976	9.593170	10.406829	36
25	9.562468	9.968926	9.593542	10.406457	35
26	9.562790	9.968877	9.593914	10.406086	34
27	9.563112	9.968827	9.594285	10.405715	33
28	9.563433	9.968777	9.594656	10.405344	32
29	9.563754	9.968728	9.595027	10.405073	31
30	9.564075	9.968678	9.595397	10.404602	30
	Co-sine	Sine	Co-tang.	Tangent	M

Degree 68.

Degree 21. 161

M	Sine	Co-sine	Tangent	Co-tang.	
30	9.564075	9.968678	9.595397	10.404602	30
31	9.564396	9.968628	9.595768	10.404232	29
32	9.564716	9.968578	9.596138	10.403862	28
33	9.565036	9.968528	9.596508	10.403492	27
34	9.565356	9.968478	9.596878	10.403122	26
35	9.565675	6.968428	9.597247	10.402753	25
36	9.565995	9.968378	9.597616	10.402384	24
37	9.566314	9.968328	9.597985	10.402015	23
38	9.566632	9.968278	9.598354	10.401646	22
39	9.566951	9.968228	9.598722	10.401277	21
40	9.567269	9.968178	9.599091	10.400909	20
41	9.567587	9.968128	9.599459	10.400541	19
42	9.567904	9.968078	9.599827	10.400173	18
43	9.568222	9.968027	9.600194	10.399806	17
44	9.568539	9.967977	9.600562	10.399438	16
45	9.568855	9.967927	9.600929	10.399071	15
46	9.569172	9.967876	9.601296	10.398704	14
47	9.569488	9.967826	9.601662	10.398337	13
48	9.569804	9 967775	9.602029	10.397971	12
49	9.570120	9.967725	9.602395	10.397605	11
50	9.570435	9.967674	9.602761	10.397239	10
51	9.570751	9.967623	9.603127	10.396873	9
52	9.571065	9.967573	9.603493	10.396507	8
53	9.571380	9.967522	9.603858	10.396142	7
54	9.571695	9.967471	9.604223	10.395777	6
55	9.572009	9.967420	9.604588	10.395412	5
56	9.572322	9.967370	9.604953	10.395047	4
57	9.572636	9.967319	9.605317	10.394683	3
58	9.572949	9.967268	9.605681	10.394318	2
59	9.573263	9.967217	9.606046	10.393954	1
60	9.573575	9.967166	9.606409	10.393590	0
	Co-sine	Sine	Co-tang.	Tangent	M

Degree 68.

462 Degree 22.

M	Sine	Co-sine	Tangent	Co-tang.	
0	9.573575	9.967166	9.606409	10.393590	60
1	9.573888	9.967115	9.606773	10.393227	59
2	9.574200	9.967064	9.607136	10.392863	58
3	9.574512	9.967012	9.607500	10.392500	57
4	9.574824	9.966961	9.607862	10.392137	56
5	9.575135	9.966910	9.608225	10.391774	55
6	9.575447	9.966859	9.608588	10.391412	54
7	9.575758	9.966807	9.608950	10.391050	53
8	9.576068	9.966756	9.609312	10.390688	52
9	9.576379	9.966705	9.609674	10.390326	51
10	9.576689	9.966653	9.600036	10.389964	50
11	9.576999	9.966602	9.610397	10.389603	49
12	9.577309	9.966550	9.610758	10.389241	48
13	9.577618	9.966499	9.611119	10.388880	47
14	9.577927	9.966447	9.611480	10.388520	46
15	9.578236	9.966395	9.611841	10.388159	45
16	9.578545	9.966344	9.612201	10.387799	44
17	9.578853	9.966292	9.612561	10.387438	43
18	9.579161	9.966240	9.612921	10.387078	42
19	9.579469	9.966188	9.613281	10.386719	41
20	9.579777	9.966136	9.613641	10.386359	40
21	9.580084	9.966084	9.614000	10.386000	39
22	9.580392	9.966032	9.614359	10.385641	38
23	9.580698	9.965980	9.614718	10.385282	37
24	9.581005	9.965928	9.615077	10.384923	36
25	9.581311	9.965876	9.615435	10.384565	35
26	9.581618	9.965824	9.615793	10.384207	34
27	9.581923	9.965772	9.616151	10.383448	33
28	9.582229	9.965720	9.616509	10.383491	32
29	9.582534	9.965668	9.616867	10.383133	31
30	9.582840	9.965615	9.617224	10.382776	30
	Co sine	Sine	Co-tang.	Tangent	M

Degree 67.

M	Sine	Co-sine	Tangent	Co-tang.	
30	9.582840	9.965615	9.617224	10.382776	30
31	9.583144	9.965563	9.617581	10.382418	29
32	9.583449	9.965511	9.617938	10.382061	28
33	9.583753	9.965458	9.618295	10.381705	27
34	9.584058	9.965406	9.618652	10.381348	26
35	9.584361	9.965353	9.619008	10.380992	25
36	9.584665	9.965301	9.619364	10.380635	24
37	9.584968	9.965248	9.619720	10.380279	23
38	9.585271	9.965195	9.620076	10.379924	22
39	9.585574	9.965143	9.620432	10.379568	21
40	9.585877	9.965090	9.620787	10.379213	20
41	9.586179	9.965037	9.621142	10.378858	19
42	9.586481	9.964984	9.621497	10.378503	18
43	9.586783	9.964931	9.621852	10.378148	17
44	9.587085	9.964878	9.622206	10.377793	16
45	9.587386	9.964825	9.622561	10.377439	15
46	9.587687	9.964772	9.622915	10.377085	14
47	9.587988	9.964719	9.623269	10.376731	13
48	9.588289	9.964666	9.623623	10.376377	12
49	9.588589	9.964613	9.623976	10.376024	11
50	9.588890	9.964560	9.624330	10.375670	10
51	9.589190	9.964507	9.624683	10.375317	9
52	9.589489	9.964454	9.625036	10.374964	8
53	9.589789	9.964400	9.625388	10.374612	7
54	9.590088	9.964347	9.625741	10.374259	6
55	9.590387	9.964294	9.626093	10.373907	5
56	9.590686	9.964240	9.626445	10.373555	4
57	9.590984	9.964187	9.626797	10.373203	3
58	9.591282	9.964133	9.627149	10.372850	2
59	9.591580	9.964080	9.627501	10.372499	1
60	9.591878	9.964026	9.627852	10.372148	0
	Co-sine	Sine	Co-tang.	Tangent	M

Degree 67.

M	Sine	Co-sine	Tangent	Co-tang.	
0	9.591878	9.964026	9.627852	10.372148	60
1	9.592175	9.963972	9.628203	10.371797	59
2	9.592473	9.963919	9.628554	10.371446	58
3	9.592770	9.963865	9.628905	10.371095	57
4	9.593067	9.963811	9.629255	10.370744	56
5	9.593363	9.963757	9.629606	10.370394	55
6	9.593659	9.963703	9.629956	10.370044	54
7	9.593955	9.963650	9.630306	10.369694	53
8	9.594251	9.963596	9.630655	10.369344	52
9	9.594547	9.963542	9.631005	10.368995	51
10	9.594842	9.963488	9.631354	10.368645	50
11	9.595137	9.963433	9.631704	10.368296	49
12	9.595432	9.963379	9.632053	10.367947	48
13	9.595727	9.963325	9.632401	10.367598	47
14	9.596021	9.963271	9.632750	10.367250	46
15	9.596315	9.963217	9.633098	10.366901	45
16	9.596610	9.963102	9.633447	10.366553	44
17	9.596903	9.963108	9.633795	10.366205	43
18	9.597196	9.963054	9.634143	10.365857	42
19	9.597490	9.962999	9.634490	10.365510	41
20	9.597783	9.962945	9.634838	10.365162	40
21	9.598075	9.962892	9.635185	10.364815	39
22	9.598368	9.962836	9.635530	10.364468	38
23	9.598660	9.962781	9.635879	10.364121	37
24	9.598952	9.962726	9.636226	10.363774	36
25	9.599244	9.962672	9.636571	10.363428	35
26	9.599536	9.962617	9.636918	10.363081	34
27	9.599827	9.962562	9.637205	10.362735	33
28	9.600118	9.962507	9.637610	10.362389	32
29	9.600409	9.962453	9.637956	10.362044	31
30	9.600700	9.962398	9.638302	10.361698	30
	Co-sine	Sine	Co-tang.	Tangent	M

M	Sine	Co-sine	Tangent	Co-tang.	
30	9.600700	9.967398	9.638302	10.361698	30
31	9.600990	9.962343	9.638647	10.361353	29
32	9.601280	9.962288	9.638992	10.361007	28
33	9.601570	9.962233	9.639337	10.360662	27
34	9.601860	9.962178	9.639682	10.360318	26
35	9.602149	9.962122	9.640027	10.359973	25
36	9.602439	9.962067	9.640371	10.359629	24
37	9.602728	9.962012	9.640716	10.359284	23
38	9.603017	9.961957	9.641060	10.358940	22
39	9.603305	9.961902	9.641404	10.358596	21
40	9.603594	9.961846	9.641747	10.358253	20
41	9.603882	9.961791	9.642091	10.357909	19
42	9.604170	9.961735	9.642434	10.357566	18
43	9.604457	9.961680	9.642777	10.357223	17
44	9.604745	9.961624	9.643120	10.356980	16
45	9.605032	9.961569	9.643463	10.356537	15
46	9.605319	9.961513	9.643806	10.356194	14
47	9.605606	9.961458	9.644148	10.355852	13
48	9.605892	9.961402	9.644490	10.355510	12
49	9.606179	9.961346	9.644832	10.355168	11
50	9.606465	9.961290	9.645174	10.354826	10
51	9.606750	9.961235	9.645516	10.354484	9
52	9.607036	9.961179	9.645857	10.354142	8
53	9.607322	9.961123	9.646199	10.353801	7
54	9.607607	9.961067	9.646540	10.353460	6
55	9.607892	9.961011	9.646881	10.353119	5
56	9.608176	9.960955	9.647222	10.352778	4
57	9.608461	9.960899	9.647562	10.352438	3
58	9.608745	9.960842	9.647903	10.352097	2
59	9.609029	9.960786	9.648243	10.351757	1
60	9.609313	9.960730	9.648583	10.351417	0
	Co-sine	Sine	Co-tang.	Tangent	M

M	Sine	*Co-sine*	Tangent	*Co-tang.*	
0	9.609313	9.960730	9.648583	10.351417	60
1	9.609597	9.960674	9.648923	10.351077	59
2	9.609880	9.960617	9.649263	10.350737	58
3	9.610163	9.960561	9.649602	10.350398	57
4	9.610446	9.960505	9.649942	10.350058	56
5	9.610729	9.960448	9.650281	10.349319	55
6	9.611012	9.960392	9.650620	10.349380	54
7	9.611294	9.960335	9.650959	10.349041	53
8	9.611576	9.960279	9.651297	10.348703	52
9	9.611858	9.960222	9.651636	10.348364	51
10	9.612140	9.960165	9.651974	10.348026	50
11	9.612421	9.960109	9.652312	10.347688	49
12	9.612702	9.960052	9.652650	10.347350	48
13	9.612983	9.959995	9.652988	10.347012	47
14	9.613264	9.959938	9.653326	10.346674	46
15	9.613545	9.959881	9.653663	10.346337	45
16	9.613825	9.959824	9.654000	10.345999	44
17	9.614105	9.959768	9.654337	10.345662	43
18	9.614385	9.959710	9.654674	10.345325	42
19	9.614665	9.959653	9.655011	10.344989	41
20	9.614944	9.959596	9.655348	10.344652	40
21	9.615223	9.959539	9.655684	10.344316	39
22	9.615502	9.959482	9.656020	10.343980	38
23	9.615781	9.959425	9.656356	10.343643	37
24	9.616060	9.959367	9.656692	10.343308	36
25	9.616338	9.959310	9.657028	10.342972	35
26	9.616616	9.959253	9.657363	10.342636	34
27	9.616894	9.959195	9.657699	10.342301	33
28	9.617172	9.959138	9.658034	10.341966	32
29	9.617450	9.959080	9.658369	10.341531	31
30	9.617727	9.959023	9.658704	10.341296	30
	Co-sine	Sine	*Co-tang.*	Tangent	M

M	Sine	Co-fine	Tangent	Co-tang.	
30	9.617727	9.959023	9.658704	10.341296	30
31	9.618004	9.958965	9.659039	10.340926	29
32	9.618281	9.958908	9.659373	10.340627	28
33	9.618558	9.958850	9.659708	10.340292	27
34	9.618834	9.958792	9.660042	10.339958	26
35	9.619110	9.958734	9.660376	10.339624	25
36	9.619386	9.958677	9.660710	10.339290	24
37	9.619662	9.958619	9.661043	10.338957	23
38	9.619938	9.958561	9.661377	10.338623	22
39	9.620213	9.958503	9.661710	10.338290	21
40	9.620488	9.958445	9.662043	10.337956	20
41	9.620763	9.958387	9.662376	10.337623	19
42	9.621038	9.958329	9.662709	10.337291	18
43	9.621313	9.958271	9.663042	10.336958	17
44	9.621587	9.958212	9.663374	10.336625	16
45	9.621861	9.958154	9.663707	10.336293	15
46	9.622135	9.958096	9.664039	10.335961	14
47	9.622409	9.958038	9.664371	10.335629	13
48	9.622682	9.957979	9.664703	10.335297	12
49	9.622956	9.957921	9.665035	10.334965	11
50	9.623229	9.957862	9.665366	10.334634	10
51	9.623502	9.957804	9.665697	10.334302	9
52	9.623774	9.957745	9.666029	10.333971	8
53	9.624047	9.957687	9.666360	10.333640	7
54	9.624319	9.957628	9.666691	10.333309	6
55	9.624591	9.957570	9.667021	10.332979	5
56	9.624863	9.957511	9.667352	10.332648	4
57	9.625134	9.957452	9.667682	10.332318	3
58	9.625406	9.957393	9.668012	10.331987	2
59	9.625677	9.957334	9.668343	10.331657	1
60	9.625948	9.957276	9.668672	10.331327	0
	Co-fine	Sine	Co-tang.	Tangent	M

M	Sine	Co-sine	Tangent	Co-tang.	
0	9.625948	9.957276	9.668672	10.331327	60
1	9.626219	9.957217	9.669002	10.330998	59
2	9.626490	9.957158	9.669332	10.330668	58
3	9.626760	9.957099	9.669661	10.330339	57
4	9.627030	9.957040	9.669990	10.330009	56
5	9.627300	9.956981	9.670320	10.329680	55
6	9.627570	9.956922	9.670649	10.329351	54
7	9.627840	9.956862	9.670977	10.329022	53
8	9.628109	9.956803	9.671306	10.328694	52
9	9.628378	9.956744	9.671634	10.328365	51
10	9.628647	9.956684	9.671963	10.328037	50
11	9.628916	9.956625	9.672291	10.327709	49
12	9.629184	9.956565	9.672619	10.327381	48
13	9.629453	9.9562c8	9.672947	10.327053	47
14	9.629721	9.956446	9.673274	10.326725	46
15	9.629989	9.956387	9.673603	10.326398	45
16	9.630257	9.956327	9.673929	10.326070	44
17	9.630524	9.956267	9.674256	10.325743	43
18	9.630792	9.956208	9.674584	10.325416	42
19	9.631059	9.956148	9.674910	10.325089	41
20	9.631326	6.956088	9.675237	10.324763	40
21	9.631592	9.956029	9.675564	10.324436	39
22	9.631859	9.955969	9.675890	10.324110	38
23	9.632125	9.955909	9.676216	10.323783	37
24	9.632392	9.955849	9.676543	10.323457	36
25	9.632657	9.955789	9.676869	10.323131	35
26	9.632923	9.955739	9.677194	10.322805	34
27	9.633189	9.955669	9.677520	10.322480	33
28	9.633454	9.955609	9.677845	10.322154	32
29	9.633719	9.955548	9.678171	10.321829	31
30	9.633984	9.955488	9.678496	10.321504	30
	Co-fine	Sine	Co-tang.	Tangent	M

Degree 25. 469

M	Sine	Co-sine	Tangent	Co-tang.	
30	9.633984	9.955488	9.678496	10.321504	30
31	9.634249	9.955428	9.678821	10.321179	29
32	9.634514	9.955367	9.679146	10.320854	28
33	9.634778	9.955307	9.679471	10.320529	27
34	9.635042	9.955246	9.679795	10.320205	26
35	9.635306	9.955186	9.680120	10.319880	25
36	9.635570	9.955125	9.680444	10.319556	24
37	9.635833	9.955065	9.680768	10.319232	23
38	9.636097	9.955004	9.681092	10.318908	22
39	9.636360	9.954944	9.681416	10.318584	21
40	9.636623	9.954883	9.681740	10.318260	20
41	9.636886	9.954823	9.682063	10.317937	19
42	9.637148	9.954762	9.682386	10.317613	18
43	9.637411	9.954701	9.682710	10.317290	17
44	9.637673	9.954640	9.683033	10.316967	16
45	9.637935	9.954579	9.683356	10.316644	15
46	9.638197	9.954518	9.683678	10.316321	14
47	9.638458	9.954457	9.684001	10.315999	13
48	9.638720	9.954396	9.684324	10.315676	12
49	9.638981	9.954335	9.684646	10.315354	11
50	9.639242	9.954274	9.684968	10.315032	10
51	9.639503	9.954213	9.685290	10.314710	9
52	9.639764	9.954152	9.685612	10.313388	8
53	9.640024	9.954090	9.685934	10.314066	7
54	9.640284	9.954029	9.686255	10.313745	6
55	9.640544	9.953968	9.686577	10.313423	5
56	9.640804	9.953906	9.686898	10.313102	4
57	9.641064	9.953845	9.687219	10.312781	3
58	9.641323	9.953783	9.687540	10.312460	2
59	9.641583	9.953722	9.687861	10.312138	1
60	9.641842	9.953660	9.688182	10.311818	0
	Co-sine	Sine	Co-tang.	Tangent	M

Degree 64.

M	Sine	*Co-fine*	Tangent	*Co-tang.*	
0	9.641842	9.953660	9.688182	10.311818	60
1	9.642101	9.953598	9.688502	10.311498	59
2	9.642360	9.953537	9.688823	10.311177	58
3	9.642618	9.953475	9.689143	10.310857	57
4	9.642876	9.953413	9.689463	10.310537	56
5	9.643135	9.953351	9.689783	10.310237	55
6	9.643393	9.953290	9.690103	10.309897	54
7	9.643650	9.953228	9.690423	10.309577	53
8	9.643908	9.953166	9.690742	10.309258	52
9	9.644165	9.953104	9.691063	10.308938	51
10	9.644423	9.953042	9.691381	10.308619	50
11	9.644680	9.952980	9.691700	10.308300	49
12	9.644936	9.952917	9.692019	10.307981	48
13	9.645193	9.952855	9.692338	10.307662	47
14	9.645449	9.952793	9.692656	10.307343	46
15	9.645706	9.952731	9.692975	10.307025	45
16	9.645962	9.952668	9.693293	10.306706	44
17	9.646218	9.952606	9.693612	10.306388	43
18	9.646473	9.952544	9.693930	10.306070	42
19	9.646729	9.952481	9.694248	10.305752	41
20	9.646984	9.952419	9.694566	10.305434	40
21	9.647239	9.952356	9.694883	10.305117	39
22	9.647494	9.952294	9.695201	10.304799	38
23	9.647749	9.952231	9.695518	10.304482	37
24	9.648004	9.952168	9.695835	10.304164	36
25	9.648258	9.952105	9.696153	10.303847	35
26	9.648512	9.952043	9.696470	10.303530	34
27	9.648766	9.951980	9.696786	10.303213	33
28	9.649020	9.951917	9.697103	10.302897	32
29	9.649274	9.951854	9.697420	10.302580	31
30	9.649527	9.951791	9.697738	10.302264	30
	Co-fine	Sine	*Co-tang.*	Tangent	M

153

M	Sine	Co-sine	Tangent	Co-tang.	
30	9.649527	9.951791	9.697738	10.302264	30
31	9.649781	9.951728	9.698052	10.301947	29
32	9.650034	9.951665	9.698369	10.301631	28
33	9.650287	9.951602	9.698685	10.301315	27
34	9.650519	9.951539	9.699001	10.300999	26
35	9.650798	9.951476	9.699316	10.300684	25
36	9.651044	9.951412	9.699632	10.300368	24
37	9.651296	9.951349	9.699947	10.300052	23
38	9.651548	9.951286	9.700263	10.299737	22
39	9.651800	9.951222	9.700578	10.299422	21
40	9.652052	9.951159	9.700893	10.299107	20
41	9.652303	9.951095	9.701208	10.298792	19
42	9.652555	9.951032	9.701522	10.298477	18
43	9.652806	9.950968	9.701837	10.298163	17
44	9.653057	9.950905	9.702152	10.297848	16
45	9.653307	9.950841	9.702466	10.297534	15
46	9.653558	9.950777	9.702780	10.297219	14
47	9.653808	9.950714	9.703095	10.296905	13
48	9.654059	9.950650	9.703409	10.296591	12
49	9.654309	9.950586	9.703722	10.296277	11
50	9.654558	9.950522	9.704036	10.295964	10
51	9.654808	9.950458	9.704350	10.295656	9
52	9.655057	9.950394	9.704663	10.295337	8
53	9.655307	9.950330	9.704976	10.295023	7
54	9.655556	9.950266	9.705290	10.294710	6
55	9.655805	9.950202	9.705603	10.294397	5
56	9.656053	9.950138	9.705915	10.294084	4
57	9.656302	9.950074	9.706228	10.293771	3
58	9.656550	9.950009	9.706541	10.293459	2
59	9.656799	9.949945	9.706853	10.293146	1
60	9.656347	9.949881	9.707166	10.292834	0
	Co-sine	Sine	Co-tang.	Tangent	M

M	Sine	Co-sine	Tangent	Co-tang.	
0	9.657047	9.949880	9.707166	10.292834	60
1	9.657295	9.949816	9.707478	10.292523	59
2	9.657542	9.949752	9.707790	10.292210	58
3	9.657790	9.949687	9.708102	10.291897	57
4	9.658037	9.949623	9.708414	10.291586	56
5	9.658284	9.949598	9.708726	10.291274	55
6	9.658531	9.949494	9.709037	10.290962	54
7	9.658777	9.949429	9.709349	10.290651	53
8	9.659024	9.949364	9.709660	10.290340	52
9	9.659271	9.949300	9.709971	10.290029	51
10	9.659517	9.949235	9.710282	10.289718	50
11	9.659763	9.949170	9.710593	10.289407	49
12	9.660009	9.949105	9.710904	10.289096	48
13	9.660255	9.949040	9.711214	10.288785	47
14	9.660500	9.948976	9.711525	10.288475	46
15	9.660746	9.948910	9.711836	10.288164	45
16	9.660991	9.948845	9.712146	10.287854	44
17	9.661036	9.948760	9.712456	10.287544	43
18	9.661481	9.948715	9.712766	10.287234	42
19	9.661726	9.948650	9.713076	10.286924	41
20	9.661970	9.948584	9.713386	10.286614	40
21	9.662214	9.948519	9.713695	10.286305	39
22	9.662459	9.948453	9.714005	10.285995	38
23	9.662702	9.948388	9.714314	10.285686	37
24	9.662947	9.948323	9.714624	10.285376	36
25	9.663190	9.948257	9.714933	10.285067	35
26	9.663433	9.948191	9.715241	10.284758	34
27	9.663677	9.948126	9.715550	10.284449	33
28	9.663920	9.948060	9.715859	10.284140	32
29	9.664163	9.947995	9.716168	10.283832	31
30	9.664406	9.947929	9.716477	10.283523	30
	Co-sine	Sine	Co-tang.	Tangent	M

M	Sine	Co-sine	Tangent	Co-tang.	
30	9.664406	9.947929	9.716477	10.283523	30
31	9.664648	9.947863	9.716785	10.283215	29
32	9.664891	9.947797	9.717093	10.282907	28
33	9.665133	9.947731	9.717401	10.282598	27
34	9.665375	9.947665	9.717709	10.282290	26
35	9.665617	9.947599	9.718017	10.281983	25
36	9.665858	9.947533	9.718325	10.281675	24
37	9.666100	9.947467	9.718633	10.281367	23
38	9.666341	9.947401	9.718940	10.281060	22
39	9.666583	9.947335	9.719248	10.280752	21
40	9.666824	9.947269	9.719555	10.280445	20
41	9.667065	9.947203	9.719862	10.280138	19
42	9.667305	9.947136	9.720169	10.279831	18
43	9.667546	9.947070	9.720476	10.279524	17
44	9.667786	9.947004	9.720783	10.279217	16
45	9.668026	9.946937	9.721089	10.278911	15
46	9.668266	9.946871	9.721395	10.278604	14
47	9.668506	9.946804	9.721702	10.278298	13
48	9.668746	9.946738	9.722008	10.277991	12
49	9.668986	9.946671	9.722315	10.277685	11
50	9.669225	9.946604	9.722621	10.277379	10
51	9.669464	9.946537	9.722927	10.277073	9
52	9.669703	9.946471	9.723232	10.276768	8
53	9.669942	9.946404	9.723538	10.276462	7
54	9.670181	9.946337	9.723843	10.276156	6
55	9.670419	9.946270	9.724149	10.275851	5
56	9.670657	9.946203	9.724454	10.275546	4
57	9.670896	9.946136	9.724759	10.275240	3
58	9.671134	9.946069	9.725065	10.274935	2
59	9.671372	9.946002	9.725369	10.274630	1
60	9.671609	9.945935	9.725674	10.274326	0
	Co-fine.	Sine	Co-tang.	Tangent	M

M	Sine	Co-sine	Tangent	Co-tang.	
0	9.671609	9.945935	9.725674	10.274326	60
1	9.671847	9.945868	9.725979	10.274021	59
2	9.672084	9.945800	9.726284	10.273816	58
3	9.672321	9.945733	9.726588	10.273412	57
4	9.672558	9.945666	9.726892	10.273107	56
5	9.672795	9.945598	9.727197	10.272803	55
6	9.673032	9.945531	9.727501	10.272499	54
7	9.673268	9.945463	9.727805	10.272195	53
8	9.673505	9.945396	9.728109	10.271891	52
9	9.673741	9.945328	9.728412	10.271587	51
10	9.673977	9.945261	9.728716	10.271284	50
11	9.674213	9.945193	9.729020	10.270980	49
12	9.674448	9.945125	9.729323	10.270677	48
13	9.674684	9.945058	9.729626	10.270374	47
14	9.674919	9.944990	9.729929	10.270070	46
15	9.675154	9.944922	9.730232	10.269767	45
16	9.675389	9.944854	9.730535	10.269464	44
17	9.675623	9.944786	9.730838	10.269162	43
18	9.675859	9.944718	9.731141	10.268859	42
19	9.676094	9.944650	9.731443	10.268559	41
20	9.676328	9.944582	9.731746	10.268254	40
21	9.676562	9.944514	9.732048	10.267952	39
22	9.676796	9.944446	9.732351	10.267649	38
23	9.677030	9.944377	9.732653	10.267347	37
24	9.677264	9.944309	9.732955	10.267045	36
25	9.677497	9.944241	9.733257	10.266743	35
26	9.677731	9.944172	9.733558	10.266441	34
27	9.677964	9.944104	9.733860	10.266140	33
28	9.678197	9.944016	9.734162	10.265838	32
29	9.678430	9.943967	9.734463	10.265537	31
30	9.678663	9.943898	9.734764	10.265236	30
	Co-sine.	Sine	Co-tang.	Tangent	M

Degree 28. 475

M	Sine	Co-sine	Tangent	Co-tang.	
30	9.678663	9.943898	9.734764	10.265236	30
31	9.678895	9.943830	9.735666	10.264934	29
32	9.679128	9.943761	9.735362	10.264633	28
33	9.679360	9.943692	9.735668	10.264332	27
34	9.679592	9.943624	9.735968	10.264031	26
35	9.679824	9.943555	9.736269	10.263731	25
36	9.680056	9.943486	9.736570	10.263430	24
37	9.680288	9.943417	9.736870	10.263130	23
38	9.680519	9.943348	9.737171	10.262829	22
39	9.680750	9.943279	9.737471	10.262529	21
40	9.680982	9.943210	9.737771	10.262229	20
41	9.681213	9.943141	9.738071	10.261929	19
42	9.681443	9.943072	9.738371	10.261629	18
43	9.681674	9.943003	9.738671	10.261329	17
44	9.681904	9.942933	9.738971	10.261029	16
45	9.682135	9.942864	9.739271	10.260729	15
46	9.682365	9.942795	9.739570	10.260430	14
47	9.682595	9.942725	9.739870	10.260130	13
48	9.682825	9.942656	9.740169	10.259831	12
49	9.683055	9.942587	9.740468	10.259532	11
50	9.683284	9.942517	9.740767	10.259233	10
51	9.683514	9.942448	9.741066	10.258934	9
52	9.683743	9.942378	9.741365	10.258635	8
53	9.683972	9.942308	9.741664	10.258336	7
54	9.684201	9.942239	9.741962	10.258038	6
55	9.684430	9.942169	9.742261	10.257739	5
56	9.684658	9.942099	9.742559	10.257441	4
57	9.684887	9.942029	9.742858	10.257142	3
58	9.685115	9.941959	9.743156	10.256844	2
59	9.685343	9.941889	9.743454	10.256546	1
60	9.685571	9.941819	9.743751	10.256248	0
	Co-sine	Sine	Co-tang.	Tangent	M

Degree 61.

M	Sine	Co-sine	Tangent	Co-tang.	
0	9.685571	9.941819	9743752	10.256248	60
1	9.685799	9.941749	9.744050	10.255950	59
2	9.686027	9.941679	9.744348	10.255652	58
3	9.686254	9.941609	9.744645	10.255355	57
4	9.686482	9.941539	9.744943	10.255057	56
5	9.686709	9.941468	9.745240	10.254760	55
6	9.686936	9.941398	9.745538	10.254462	54
7	9.687163	9.941328	9.745835	10.254165	53
8	9.687389	9.941257	9.746132	10.253868	52
9	9.687616	9.941187	9.746429	10.253571	51
10	9.687842	9.941116	9.746726	10.253274	50
11	9.688069	9.941046	9.747023	10.252977	49
12	9.688295	9.940975	9.747319	10.252680	48
13	9.688523	9.940905	9.747616	10.252384	47
14	9.688747	9.940834	9.747912	10.252087	46
15	9.688972	9.940763	9.748209	10.251791	45
16	9.689198	9.940693	9.748505	10.251495	44
17	9.689421	9.940622	9.748801	10.251199	43
18	9.689648	7.940551	9.749097	10.250902	42
19	9.689873	9.940480	9.749393	10.250607	41
20	9.690098	9.940409	9 749689	10.250311	40
21	9.690323	9.940338	9.749985	10.250015	39
22	9.690548	9.940267	9.750281	10.249719	38
23	9.690772	9.940196	9.750576	10.249424	37
24	9.690996	9.940125	9.750872	10.249128	36
25	9.691220	9.940053	9.751167	10.248833	35
26	9.691444	9.939982	9.751462	10.248538	34
27	9.691668	9.939911	9.751757	10.248243	33
28	9.691892	9.939840	9.752052	10.247948	32
29	9.692115	9.939768	9.752347	10.247653	31
30	9.692339	9.939697	9.752642	10.247358	30
	Co-sine	Sine	Co-tang.	Tangent	M

Degree 29. 477

M	Sine	Co-sine	Tangent	Co-tang.	
30	9.692339	9.939697	9.752642	10.247358	30
31	9.692562	9.939625	9.752937	10.247063	29
32	9.692785	9.939554	9.753231	10.246769	28
33	9.693008	9.939482	9.753526	10.246474	27
34	9.693231	9.939410	9.753820	10.246180	26
35	9.693453	9.939339	9.754115	10.245885	25
36	9.693676	9.939267	9.754409	10.245591	24
37	9.693898	9.939195	9.754703	10.245297	23
38	9.694120	9.939123	9.754997	10.245003	22
39	9.694342	9.939051	9.755291	10.244709	21
40	9.694564	9.938980	9.755584	10.244415	20
41	9.694786	9.938908	9.755878	10.244122	19
42	9.695007	9.938835	9.756172	10.243828	18
43	9.695229	9.938763	9.756465	10.243535	17
44	9.695450	9.938691	9.756759	10.243241	16
45	9.695671	9.938619	9.757052	10.242948	15
46	9.695892	9.938547	9.757345	10.242655	14
47	9.696113	9.938475	9.757638	10.242362	13
48	9.696334	9.938402	9.757931	10.242069	12
49	9.696554	9.938330	9.758224	10.241776	11
50	9.696774	9.938257	9.758517	10.241483	10
51	9.696995	9.938185	9.758810	10.241190	9
52	9.697215	9.938112	9.759102	10.240898	8
53	9.697435	9.938040	9.759395	10.240605	7
54	9.697654	9.937967	9.759687	10.240313	6
55	9.697874	9.937895	9.759979	10.240021	5
56	9.698093	9.937822	9.760271	10.239728	4
57	9.698313	9.937749	9.760564	10.239436	3
58	9.698532	9.937676	9.760856	10.239144	2
59	9.698751	9.937603	9.761147	10.238852	1
60	9.698970	9.937531	9.761439	10.238561	0
	Co-sine	Sine	Co-tang.	Tangent	M

Degree 60.

M	Sine	Co-sine	Tangent	Co-tang.	
0	9.698970	9.937531	9.761439	10.238561	60
1	9.699189	9.937458	9.761731	10.238269	59
2	9.699407	9.937385	9.762023	10.237977	58
3	9.699626	9.937312	9.762314	10.237686	57
4	9.699844	9.937238	9.762606	10.237394	56
5	9.700062	9.937165	9.762897	10.237103	55
6	7.700280	9.937092	9.763188	10.236812	54
7	9.700498	9.937019	9.763479	10.236521	53
8	9.700716	9.936945	9.763770	10.236230	52
9	9.700933	9.936872	9.764061	10.235939	51
10	9.701151	9.936799	9.764352	10.235648	50
11	9.701568	9.936725	9.764643	10.235357	49
12	9.701585	9.936652	9.764933	10.235067	48
13	9.701802	9.936578	9.765224	10.234776	47
14	9.702019	9.936505	9.765514	10.234486	46
15	9.702236	9.936431	9.765805	10.234195	45
16	9.702452	9.936357	9.766095	10.233905	44
17	9.702669	9.936284	9.766385	10.233615	43
18	9.702885	9.936210	9.766675	10.233325	42
19	9.703101	9.936136	9.766965	10.233035	41
20	9.703317	9.936062	9.767255	10.232745	40
21	9.703533	9.935988	9.767545	10.232455	39
22	9.703748	9.935914	9.767834	10.232166	38
23	9.703964	9.935840	9.768124	10.231876	37
24	9.704179	9.935766	9.768413	10.231587	36
25	9.704395	9.935692	9.768703	10.231297	35
26	9.704610	9.935618	9.768992	10.231008	34
27	9.704820	9.935543	9.769281	10.230719	33
28	9.705040	9.935469	9.769570	10.230430	32
29	9.705254	9.935395	9.769859	10.230141	31
30	9.705469	9.935320	9.770148	10.229852	30
	Co-sine	Sine	Co-tang.	Tangent	M

Degree 30. 479

M	Sine	Co-sine	Tangent	Co-tang.	
30	9.705469	9.935320	9.770148	10.229852	30
31	9.705683	9.935246	9.770437	10.229563	29
32	9.705897	9.935171	9.770726	10.229274	28
33	9.706112	9.935097	9.771015	10.228985	27
34	9.706327	9.935022	9.771303	10.228696	26
35	9.706539	9.934948	9.771592	10.228408	25
36	9.706753	9.934873	9.771880	10.228120	24
37	9.706967	9.934798	9.772168	10.227832	23
38	9.707180	9.934723	9.772456	10.227543	22
39	9.707393	9.934649	9.772745	10.227255	21
40	9.707606	9.934574	9.773033	10.226967	20
41	9.707819	9.934499	9.773321	10.226679	19
42	9.708032	9.934424	9.773608	10.226391	18
43	9.708245	9.934349	9.773896	10.226104	17
44	9.708457	9.934274	9.774184	10.225816	16
45	9.708670	9.934199	9.774471	10.225529	15
46	9.708882	9.934123	9.774759	10.225241	14
47	9.709094	9.934048	9.775046	10.224954	13
48	9.709306	9.933973	9.775333	10.224666	12
49	9.709518	9.933897	9.775621	10.224379	11
50	9.709730	9.933822	9.775908	10.224092	10
51	9.709941	9.933747	9.776195	10.223805	9
52	9.710153	9.933671	9.776482	10.223518	8
53	9.710364	9.933596	9.776768	10.223232	7
54	9.710575	9.933520	9.777055	10.222945	6
55	9.710786	9.933444	9.777342	10.222658	5
56	9.710997	9.933369	9.777628	10.222372	4
57	9.711208	9.933293	9.777915	10.222085	3
58	9.711418	9.933217	9.778201	10.221799	2
59	9.711629	9.933141	9.778487	10.221513	1
60	9.711839	9.933066	9.778774	10.221226	0
	Co-sine	Sine	Co-tang.	Tangent	M

Degree 59.

M	Sine.	Co-sine	Tangent	Co-tang.	
0	9.711839	9.933066	9.778774	10.221226	60
1	9.712049	9.932990	9.779060	10.220940	59
2	9.712259	9.932914	9.779346	10.220654	58
3	9.712469	9.932838	9.779632	10.220368	57
4	9.712679	9.932761	9.779918	10.220082	56
5	9.712889	9.932685	9.780203	10.219796	55
6	9.713098	9.932609	9.780489	10.219511	54
7	9.713308	9.932533	9.780775	10.219225	53
8	9.713517	9.932457	9.781060	10.218940	52
9	9.713726	9.932380	9.781346	10.218654	51
10	9.713935	9.932304	9.781631	10.218369	50
11	9.714144	9.932227	9.781916	10.218084	49
12	9.714352	9.932151	9.782202	10.217799	48
13	9.714561	9.932074	9.782480	10.217514	47
14	9.714769	9.931998	9.782771	10.217229	46
15	9.714977	9.931921	9.783056	10.216944	45
16	9.715186	9.931845	9.783341	10.216659	44
17	9.715394	9.931768	9.783626	10.216374	43
18	9.715601	9.931691	9.783910	10.216090	42
19	9.715809	9.931614	9.784195	10.215805	41
20	9.716017	9.931537	9.784479	10.215520	40
21	9.716224	9.931460	9.784764	10.215236	39
22	9.716431	9.931383	9.785048	10.214952	38
23	9.716639	9.931306	9.785332	10.214668	37
24	9.716846	9.931229	9.785616	10.214384	36
25	9.717053	9.931152	9.785900	10.214099	35
26	9.717259	9.931075	9.786184	10.213816	34
27	9.717466	9.930998	9.786468	10.213532	33
28	9.717672	9.930920	9.786752	10.213248	32
29	9.717879	9.930843	9.787036	10.212964	31
30	9.718085	9.930766	9.787319	10.212681	30
	Co-sine	Sine	Co-tang.	Tangent	M

M	Sine	Co-sine	Tangent	Co-tang.	
30	9.718085	9.930766	9.787319	10.212681	30
31	9.718291	9.930688	9.787603	10.212397	29
32	9.718497	9.930611	9.787886	10.212114	28
33	9.718703	9.930533	9.788170	10.211830	27
34	9.718909	9.930456	9.788453	10.211547	26
35	9.719114	9.930378	9.788736	10.211264	25
36	9.719320	9.930300	9.789019	10.210981	24
37	9.719525	9.930223	9.789302	10.210698	23
38	9.719730	9.930145	9.789585	10.210415	22
39	9.719935	9.930067	9.789868	10.210132	21
40	9.720140	9.929989	9.790151	10.209849	20
41	9.720345	9.929911	9.790433	10.209566	19
42	9.720549	9.929833	9.790716	10.209284	18
43	9.720754	9.929755	9.790999	10.209001	17
44	9.720958	9.929677	9.791281	10.208719	16
45	9.721162	9.929599	9.791563	10.208436	15
46	9.721366	9.929521	9.791846	10.208154	14
47	9.721570	9.929442	9.792128	10.207872	13
48	9.721774	9.929364	9.792410	10.207590	12
49	9.721978	9.929286	9.792692	10.207308	11
50	9.722181	9.929207	9.792974	10.207024	10
51	9.722385	9.929129	9.793256	10.206744	9
52	9.722588	9.929050	9.793538	10.206462	8
53	9.722791	9.928972	9.793819	10.206180	7
54	9.722994	9.928893	9.794101	10.205899	6
55	9.723197	9.928814	9.794383	10.205617	5
56	9.723400	9.928736	9.794664	10.205336	4
57	9.723603	9.928657	9.794945	10.205054	3
58	9.723805	9.928578	9.795227	10.204773	2
59	9.724007	9.928499	9.795508	10.204492	1
60	9.724210	9.928420	9.795789	10.204211	0
M	Co-sine	Sine	Co-tang.	Tangent	M

M	Sine	Co-sine	Tangent	Co-tang.	
0	9.724210	9.928420	9.795789	10.204211	60
1	9.724412	9.928341	9.796070	10.203930	59
2	9.724614	9.928262	9.796351	10.203649	58
3	9.724816	9.928183	9.796632	10.203368	57
4	9.725017	9.928104	9.796913	10.203087	56
5	9.725219	9.928025	9.797194	10.202806	55
6	9.725420	9.927946	9.797474	10.202522	54
7	9.725622	9.921867	9.797753	10.202245	53
8	9.725823	9.927787	9.798036	10.201964	52
9	9.726024	9.927708	9.798316	10.201684	51
10	9.726225	9.927628	9.798596	10.201404	50
11	9.726426	9.927549	9.798877	10.201123	49
12	9.726626	9.927469	9.799157	10.200843	48
13	9.726827	9.927390	9.799437	10.200563	47
14	9.727027	9.927310	9.799717	10.200283	46
15	9.727228	9.927231	9.799997	10.200003	45
16	9.727428	9.927151	9.800277	10.199723	44
17	9.727628	9.927071	9.800557	10.199443	43
18	9.727828	9.926991	9.800836	10.199163	42
19	9.728027	9.926911	9.801116	10.198884	41
20	9.728227	9.926831	9.801396	10.198604	40
21	9.728427	9.926751	9.801675	10.198325	39
22	9.728626	9.926641	9.801953	10.198045	38
23	9.728825	9.926591	9.802234	10.197766	37
24	9.729024	9.926511	9.802513	10.197487	36
25	9.729223	9.926431	9.802792	10.197207	35
26	9.729422	9.926351	9.803072	10.196928	34
27	9.729621	9.926270	9.803351	10.196649	33
28	9.729820	9.926190	9.803630	10.196370	32
29	9.730018	9.926110	9.803908	10.196091	31
30	9.730216	9.926029	9.804187	10.195813	30
	Co-sine	Sine	Co-tang.	Tangent	M

M	Sine	Co-fine	Tangent	Co-tang.	
30	9.730216	9.926029	9.804187	10.195813	30
31	9.730415	9.925949	9.804466	10.195534	29
32	9.730613	9.925868	9.804745	10.195255	28
33	9.730811	9.925787	9.805023	10.194977	27
34	9.731009	9.925707	9.805302	10.194698	26
35	9.731206	9.925626	9.805580	10.194420	25
36	9.731404	9.925545	9.805859	10.194141	24
37	9.731601	9.925464	9.806137	10.193863	23
38	9.731799	9.925384	9.806415	10.193585	22
39	9.731996	9.925303	9.806693	10.193309	21
40	9.732193	9.925222	9.806971	10.193028	20.
41	9.732390	9.925141	9.807249	10.192751	19
42	9.732587	9.925060	9.807527	10.192433	18
43	9.732784	9.924978	9.807805	10.192195	17
44	9.732980	9.924897	9.808083	10.191917	16
45	9.733177	9.924816	9.808361	10.191639	15
46	9.733373	9.924735	9.808638	10.191362	14
47	9.733569	9.924653	9.808916	10.191084	13
48	9.733765	9.924572	9.809193	10.190807	12
49	9.733961	9.924491	9.809471	10.190529	11
50	9.734157	9.924409	9.809748	10.190252	10
51	9.734353	9.924328	9.810025	10.189975	9
52	9.734548	9.924246	9.810302	10.189697	8
53	9.734744	9.924164	9.810580	10.189420	7
54	9.734939	9.924083	9.810857	10.189143	6
55	9.735134	9.924001	9.811134	10.188866	5
56	9.735330	9.923919	9.811410	10.188589	4
57	9.735525	9.923837	9.811687	10.188313	3
58	9.735719	9.923755	9.811964	10.188036	2
59	9.735914	9.923673	9.812241	10.187759	1
60	9.736109	9.923591	9.812517	10.187483	0
	Co-fine	Sine	Co-tang.	Tangent	M

M	Sine	*Co-fine*	Tangent	*Co-tang.*	
0	9.736109	9.923591	9.812517	10.187483	60
1	9.736309	9.923509	9.812794	10.187206	59
2	9.736497	9.923427	9.813070	10.186930	58
3	9.736692	9.923345	9.813347	10.186653	57
4	9.736886	9.923263	9.813623	10.186377	56
5	9.737080	9.923180	9.813899	10.186101	55
6	9.737274	9.923098	9.814175	10.185824	54
7	9.737467	9.923016	9.814452	10.185548	53
8	9.737661	9.922933	9.814728	10.185272	52
9	9.737854	9.922851	9.815004	10.184996	51
10	9.738048	9.922768	9.815279	10.184720	50
11	9.738241	9.922686	9.815555	10.184445	49
12	9.738434	9.922603	9.815831	10.184169	48
13	9.738627	9.922520	9.816107	10.183893	47
14	9.738820	9.922438	9.816382	10.183617	46
15	9.739013	9.922355	9.816658	10.183342	45
16	9.739205	9.922272	9.816933	10.183066	44
17	9.739398	9.922189	9.817209	10.182791	43
18	9.739590	9.922106	9.817484	10.182516	42
19	9.739783	9.922023	9.817759	10.182240	41
20	9.739975	9.921940	9.818035	10.181965	40
21	9.740167	9.921857	9.818310	10.181690	39
22	9.740359	9.921774	9.818585	10.181415	38
23	9.740550	9.921691	9.818860	10.181140	37
24	9.740742	9.921607	9.819135	10.180865	36
25	9.740934	9.921524	9.819410	10.180590	35
26	9.741125	9.921441	9.819684	10.180315	34
27	9.741316	9.921357	9.819959	10.180041	33
28	9.741507	9.921274	9.820234	10.179766	32
29	9.741698	9.921190	9.820508	10.179492	31
30	9.741889	9.921107	9.820783	10.179217	30
	Co-fine	Sine	*Co-tang.*	Tangent	M

Degree 56.

M	Sine	Co-sine	Tangent	Co-tang.	
30	9.741889	9.921107	9.820783	10.179217	30
31	9.742080	9.921023	9.821057	10.178943	29
32	9.742271	9.920939	9.821332	10.178668	28
33	9.742461	9.920855	9.821606	10.178394	27
34	9.742652	9.920772	9.821880	10.178120	26
35	9.742842	9.920688	9.822154	10.177846	25
36	9.743032	9.920604	9.822429	10.177571	24
37	9.743223	9.920520	9.822703	10.177297	23
38	9.743412	9.920436	9.822977	10.177023	22
39	9.743602	9.920352	9.823250	10.176739	21
40	9.743792	9.920268	9.823524	10.176476	20
41	9.743982	9.920184	9.823798	10.176202	19
42	9.744171	9.920099	9.824072	10.175928	18
43	9.744361	9.920015	9.824345	10.175655	17
44	9.744550	9.919931	9.824619	10.175381	16
45	9.744739	9.919846	9.824892	10.175108	15
46	9.744928	9.919762	9.825166	10.174834	14
47	9.745117	9.919677	9.825439	10.174560	13
48	9.745306	9.919593	9.825713	10.174287	12
49	9.745494	9.919508	9.825986	10.174014	11
50	9.745683	9.919424	9.826259	10.173741	10
51	9.745871	9.919339	9.826532	10.173468	9
52	9.746059	9.919254	9.826805	10.173195	8
53	9.746248	9.919169	9.827078	10.172922	7
54	9.746436	9.919084	9.827351	10.172649	6
55	9.746624	9.918999	9.827624	10.172376	5
56	9.746811	9.918915	9.827897	10.172103	4
57	9.746999	9.918830	9.828170	10.171830	3
58	9.747187	9.918744	9.828442	10.171558	2
59	9.747374	9.918659	9.828715	10.171285	1
60	9.747562	9.918574	9.828987	10.171012	0
	Co-sine	Sine	Co-tang.	Tangent	M

M	Sine	Co-sine	Tangent	Co-tang.	
0	9.747562	9.918574	9.828987	10.171012	60
1	9.747749	9.918489	9.829260	10.170740	59
2	9.747936	9.918404	9.829532	10.170468	58
3	9.748123	9.918318	9.829805	10.170195	57
4	9.748310	9.918233	9.830077	10.169923	56
5	9.748497	9.918147	9.830349	10.169651	55
6	9.748683	9.918062	9.830621	10.169379	54
7	9.748870	9.917976	9.830891	10.166106	53
8	9.749056	9.917891	9.831165	10.168834	52
9	9.749242	9.917805	9.831437	10.168563	51
10	9.749429	9.917719	9.831709	10.168291	50
11	9.749615	9.917634	9.831981	10.168019	49
12	9.749801	9.917548	9.832253	10.167747	48
13	9.749986	9.917462	9.832525	10.167475	47
14	9.750172	9.917376	9.832796	10.167204	46
15	9.750358	9.917290	9.833068	10.166932	45
16	9.750543	9.917204	9.833339	10.166660	44
17	9.750729	9.917118	9.833621	10.166389	43
18	9.750914	9.917032	9.833882	10.166118	42
19	9.751099	9.916945	9.834154	10.165846	41
20	9.751284	9.916819	9.834425	10.165575	40
21	9.751469	9.916773	9.834696	10.165304	39
22	9.751654	9.916686	9.834967	10.165033	38
23	9.751838	9.916600	9.835238	10.164762	37
24	9.752023	9.916514	9.835509	10.164491	36
25	9.752207	9.916427	9.835780	10.164220	35
26	9.752392	9.916340	9.836051	10.163949	34
27	9.752576	9.916254	9.836322	10.163678	33
28	9.752760	9.916167	9.836593	10.163407	32
29	9.752944	9.916080	9.836864	10.163136	31
30	9.753128	9.915994	9.837134	10.162866	30
	Co-sine	Sine	Co-tang.	Tangent	M

Degree 55.

M	Sine	Co-sine	Tangent	Co-tang.	
30	9.753128	9.915994	9.837134	10.162866	30
31	9.753312	9.915907	9.837405	10.162595	29
32	9.753495	9.915820	9.837675	10.162325	28
33	9.753679	9.915733	9.837946	10.162054	27
34	9.753862	9.915646	9.838216	10.161784	26
35	9.754046	9.915559	9.838487	10.161513	25
36	9.754229	9.915472	9.838757	10.161243	24
37	9.754412	9.915385	9.839027	10.160973	23
38	9.754595	9.915297	9.839297	10.160702	22
39	9.754778	9.915210	9.839568	10.160432	21
40	9.754960	9.915123	9.839838	10.160162	20
41	9.755143	9.915035	9.840108	10.159892	19
42	9.755325	9.914948	9.840378	10.159622	18
43	9.755508	9.914860	9.840647	10.159352	17
44	9.755690	9.914773	9.840917	10.159083	16
45	9.755872	9.914685	9.841187	10.158813	15
46	9.756054	9.914597	9.841457	10.158543	14
47	9.756236	9.914510	9.841726	10.158273	13
48	9.756418	9.914422	9.841996	10.158004	12
49	9.756600	9.914334	9.842266	10.157734	11
50	9.756781	9.914146	9.842505	10.157465	10
51	9.756963	9.914158	9.842804	10.157195	9
52	9.757144	9.914070	9.843074	10.156926	8
53	9.757316	9.913982	9.843343	10.156657	7
54	9.757507	9.913894	9.843612	10.156387	6
55	9.757688	9.913806	9.843882	10.156118	5
56	9.757869	9.913718	9.844151	10.155849	4
57	9.758049	9.913630	9.844420	10.155580	3
58	9.758230	9.913541	9.844689	10.155311	2
59	9.758411	9.913453	9.844958	10.155041	1
60	9.758591	9.913361	9.845227	10.154773	0
	Co-sine	Sine	Co-tang.	Tangent	M

Degree 55.

M	Sine	Co-sine	Tangent	Co-tang.	
0	9.758591	9.913364	9.845227	10.154774	60
1	9.758772	9.913276	9.845496	10.154504	59
2	9.758952	9.913187	9.845764	10.154235	58
3	9.759132	9.913099	9.846033	10.153967	57
4	9.759312	9.913010	9.846302	10.153698	56
5	9.759492	9.912921	9.846570	10.153429	55
6	9.759672	9.912833	9.846839	10.153161	54
7	9.759851	9.912744	9.847107	10.152892	53
8	9.760031	9.912655	9.847376	10.152624	52
9	9.760210	9.912566	9.847644	10.152356	51
10	9.760390	9.912477	9.847913	10.152087	50
11	9.760569	9.912388	9.848181	10.151819	49
12	9.760748	9.912299	9.848449	10.151551	48
13	9.760927	9.912210	9.848717	10.151283	47
14	9.761106	9.912121	9.848985	10.151015	46
15	9.761285	9.912031	9.849254	10.150746	45
16	9.761464	9.911942	9.849522	10.150478	44
17	9.761642	9.911853	9.849789	10.150214	43
18	9.761821	9.911763	9.850057	10.149943	42
19	9.761999	9.911674	9.850325	10.149675	41
20	9.762177	9.911584	9.850593	10.149407	40
21	9.762356	9.911495	9.850861	10.149139	39
22	9.762534	9.911405	9.851128	10.148872	38
23	9.762712	9.911315	9.851396	10.148604	37
24	9.762889	9.911226	9.851664	10.148336	36
25	9.763067	9.911136	9.851931	10.148069	35
26	9.763245	9.911046	9.852199	10.147801	34
27	9.763422	9.910956	9.852466	10.147534	33
28	9.763599	9.910866	9.852731	10.147267	32
29	9.763777	9.910776	9.853001	10.146999	31
30	9.763954	9.910686	9.853268	10.146732	30
	Co-sine	Sine	Co-tang.	Tangent	M

M	Sine	Co-sine	Tangent	Co-tang.	
30	9.763954	9.910686	9.853208	10.146732	30
31	9.764131	9.910596	9.853532	10.146465	29
32	9.764308	9.910506	9.853802	10.146198	28
33	9.764485	9.910415	9.854069	10.145930	27
34	9.764662	9.910325	9.854336	10.145664	26
35	9.764838	9.910235	9.854603	10.145397	25
36	9.765015	9.910144	9.854870	10.145130	24
37	9.765191	9.910054	9.855137	10.144863	23
38	9.765367	9.909963	9.855404	10.144596	22
39	9.765544	9.909873	9.855671	10.144329	21
40	9.765720	9.909782	9.855937	10.144063	20
41	9.765896	9.909691	9.856204	10.143796	19
42	9.766071	9.909601	9.856471	10.143529	18
43	9.766247	9.909510	9.856737	10.143263	17
44	9.766423	9.909419	9.857004	10.142996	16
45	9.766598	9.909328	9.857270	10.142730	15
46	9.766774	9.909237	9.857537	10.142463	14
47	9.766949	9.909146	9.857803	10.142197	13
48	9.767124	9.909055	9.858069	10.141931	12
49	9.767299	9.908964	9.858336	10.141664	11
50	9.767474	9.908873	9.858602	10.141398	10
51	9.767649	9.908781	9.858868	10.141132	9
52	9.767824	9.908690	9.859134	10.140866	8
53	9.767997	9.908599	9.859400	10.140600	7
54	9.768173	9.908507	9.859666	10.140334	6
55	9.768348	9.908416	9.859932	10.140068	5
56	9.768522	9.908324	9.860198	10.139802	4
57	9.768696	9.908233	9.860464	10.139536	3
58	9.768871	9.908141	9.860730	10.139270	2
59	9.769045	9.908049	9.860995	10.139005	1
60	9.769219	9.907958	9.861261	10.138739	0
	Co-sine	Sine	Co-tang.	Tangent	M

Degree 54.

M	Sine	Co-sine	Tangent	Co-tang.	
0	9.769219	9.907958	9.861261	10.138739	60
1	9.769392	9.907866	9.861527	10.138473	59
2	9.769566	9.907774	9.861792	10.138208	58
3	9.769740	9.907682	9.862058	10.137942	57
4	9.769913	9.907590	9.862323	10.137677	56
5	9.770087	9.907498	9.862589	10.137411	55
6	9.770260	9.907406	9.862854	10.137146	54
7	9.770433	9.907314	9.863119	10.136880	53
8	9.770606	9.907221	9.863385	10.136615	52
9	9.770779	9.907129	9.863650	10.136350	51
10	9.770952	9.907037	9.863915	10.136085	50
11	9.771125	9.906945	9.864180	10.135820	49
12	9.771298	9.906852	9.864445	10.135554	48
13	9.771470	9.906760	9.864710	10.135289	47
14	9.771643	9.906667	9.864975	10.135024	46
15	9.771815	9.906574	9.865240	10.134759	45
16	9.771987	9.906482	9.865505	10.134495	44
17	9.772159	9.906389	9.865770	10.134230	43
18	9.772331	9.906296	9.866035	10.133965	42
19	9.772503	9.906203	9.866300	10.133700	41
20	9.772675	9.906111	9.866564	10.133436	40
21	9.772847	9.906018	9.866829	10.133171	39
22	9.773018	9.905925	9.867094	10.132906	38
23	9.773190	9.905832	9.867358	10.132642	37
24	9.773361	9.905738	9.867623	10.132377	36
25	9.773533	9.905645	9.867887	10.132113	35
26	9.773704	9.905552	9.868152	10.131848	34
27	9.773875	9.905459	9.868416	10.131584	33
28	9.774046	9.905365	9.868680	10.131320	32
29	9.774217	9.905272	9.868945	10.131055	31
30	9.774388	9.905179	9.869209	10.130791	30
	Co-sine	Sine	Co-tang.	Tangent	M

M	Sine	Co-sine	Tangent	Co-tang.	
30	9.774388	9.905179	9.869209	10.130791	30
31	9.774558	9.905085	9.864773	10.130527	29
32	9.774729	9.904992	9.867337	10.130263	28
33	9.774899	9.904898	9.870001	10.129999	27
34	9.775070	9.904804	9.870265	10.129735	26
35	9.775240	9.904711	9.870529	10.129471	25
36	9.775410	9.904617	9.870793	10.129267	24
37	9.775580	9.904523	9.871057	10.128943	23
38	9.775750	9.904429	9.871321	10.128679	22
39	9.775920	9.904335	9.871585	10.128415	21
40	9.776090	9.904241	9.871849	10.128151	20
41	9.776259	9.904147	9.872112	10.127888	19
42	9.776429	9.904053	9.872376	10.127624	18
43	9.776598	9.903959	9.872640	10.127360	17
44	9.776768	9.903864	9.872903	10.127097	16
45	9.776937	9.903770	9.873167	10.126833	15
46	9.777106	9.903676	9.873430	10.126570	14
47	9.777275	9.903581	9.873694	10.126306	13
48	9.777444	9.903486	9.873957	10.126043	12
49	9.777613	9.903392	9.874220	10.125780	11
50	9.777781	9.903298	9.874484	10.125516	10
51	9.777950	9.903203	9.874747	10.125253	9
52	9.778119	9.903108	9.875010	10.124990	8
53	9.778287	9.903013	9.875273	10.124727	7
54	9.778455	9.902919	9.875536	10.124464	6
55	9.778623	9.902824	9.875799	10.124201	5
56	9.778792	9.902729	9.876063	10.123937	4
57	9.778960	9.902634	9.876326	10.123674	3
58	9.779129	9.902539	9.876589	10.123411	2
59	9.779295	9.902444	9.876851	10.123149	1
60	9.779463	9.902349	9.877114	10.122886	0
	Co-sine	Sine	Co-tang.	Tangent	M

Degree 53.

M	Sine	Co-fine	Tangent	Co-tang.	
0	9.779463	9.902349	9.877114	10.122885	60
1	9.779631	9.902253	9.877377	10.122623	59
2	9.779798	9.902158	9.877640	10.122360	58
3	9.779965	9.902063	9.877903	10.122097	57
4	9.780133	9.901967	9.878165	10.121834	56
5	9.780300	9.901872	9.878428	10.121572	55
6	9.780467	9.901776	9.878691	10.121309	54
7	9.780634	9.901681	9.878953	10.121047	53
8	9.780801	9.901585	9.879216	10.120784	52
9	9.780968	9.901488	9.879478	10.120522	51
10	9.781134	9.901391	9.879741	10.120259	50
11	9.781301	9.901298	9.880003	10.119997	49
12	9.781467	9.901202	9.880265	10.119734	48
13	9.781634	9.901106	9.880528	10.119472	47
14	9.781800	9.901010	9.880790	10.119210	46
15	9.781966	9.900914	9.881052	10.118948	45
16	9.782132	9.900828	9.881314	10.118686	44
17	9.782298	9.900722	9.881576	10.118424	43
18	9.782464	9.900626	9.881839	10.118161	42
19	9.782690	9.900529	9.882101	10.117899	41
20	9.782796	9.900433	9.882363	10.117637	40
21	9.782961	9.900337	9.882625	10.117375	39
22	9.783127	9.900240	9.882886	10.117114	38
23	9.783292	9.900144	9.883148	10.116852	37
24	9.783457	9.900047	9.883410	10.116590	36
25	9.783623	9.899951	9.883672	10.116328	35
26	9.783788	9.899854	9.883934	10.116066	34
27	9.783953	9.899757	9.884195	10.115805	33
28	9.784118	9.899660	9.884457	10.115543	32
29	9.784282	9.899563	9.884719	10.115281	31
30	9.784447	9.899467	9.884980	10.115020	30
	Co-fine	Sine	Co-tang.	Tangent	M

M	Sine	Co-sine	Tangent	Co-tang.	
30	9.784447	9.899467	9.884980	10.115025	30
31	9.784616	9.899370	9.885242	10.114758	29
32	9.784776	9.899273	9.885503	10.114497	28
33	9.784941	9.899175	9.885765	10.114235	27
34	9.785105	9.899078	9.886026	10.113974	26
35	9.785269	9.898981	9.886288	10.113712	25
36	9.785433	9.898884	9.886549	10.113451	24
37	9.785591	9.898787	9.886810	10.113190	23
38	9.785761	9.898689	9.887072	10.112928	22
39	9.785925	9.898592	9.887333	10.112667	21
40	9.786088	9.898494	9.887594	10.112406	20
41	9.786252	9.898397	9.887855	10.112145	19
42	9.786416	9.898299	9.888116	10.111884	18
43	9.786579	9.898201	9.888377	10.111623	17
44	9.786742	9.898104	9.888638	10.111362	16
45	9.786909	9.898006	9.888899	10.111101	15
46	9.787069	9.897908	9.889160	10.110840	14
47	9.787232	9.897810	9.889421	10.110579	13
48	9.787395	9.897112	9.889682	10.110318	12
49	9.787557	9.897614	9.889943	10.110057	11
50	9.787720	9.897516	9.890204	10.109796	10
51	9.787883	9.897418	9.890465	10.109535	9
52	9.788045	9.897320	9.890725	10.109275	8
53	9.788208	9.897222	9.890986	10.109014	7
54	9.788370	9.897123	9.891248	10.108753	6
55	9.788532	9.897025	9.891507	10.108493	5
56	9.788694	9.896926	9.891768	10.108232	4
57	9.788856	9.896828	9.892028	10.107972	3
58	9.789018	9.896729	9.892289	10.107711	2
59	9.789180	9.896631	9.892549	10.107451	1
60	9.789342	9.896532	9.892810	10 107190	0
	Co-sine	Sine	Co-tang.	Tangent	M

M	Sine	Co-sine	Tangent	Co-tang.	
0	9.789342	9.896532	9.892810	10.107190	60
1	9.789504	9.896433	9.893070	10.106930	59
2	9.789665	9.896335	9.893330	10.106669	58
3	9.789827	9.896236	9.893591	10.106409	57
4	9.789988	9.896137	9.893851	10.106149	56
5	9.790149	9.896038	9.894111	10.105889	55
6	9.790310	9.895939	9.894371	10.105628	54
7	9.790471	9.895840	9.894632	10.105368	53
8	9.790632	9.895741	9.894892	10.105108	52
9	9.790793	9.895641	9.895152	10.104844	51
10	9.790954	9.895542	9.895412	10.104588	50
11	9.791115	9.895443	9.895672	10.104328	49
12	9.791275	9.895343	9.895932	10.104068	48
13	9.791436	9.895244	9.896192	10.103808	47
14	9.791596	9.895144	9.896452	10.103548	46
15	9.791756	9.895045	9.896712	10.103288	45
16	9.791917	9.894945	9.896971	10.103028	44
17	9.792077	9.894846	9.897231	10.102769	43
18	9.792237	9.894746	9.897491	10.102509	42
19	9.792397	9.894646	9.897751	10.102249	41
20	9.792557	9.894546	9.898010	10.101990	40
21	9.792716	9.894446	9.898270	10.101730	39
22	9.792876	9.894346	9.898530	10.101470	38
23	9.793035	9.894246	9.898789	10.101211	37
24	9.793195	9.894146	9.899049	10.100951	36
25	9.793354	9.894046	9.899308	10.100692	35
26	9.793513	9.893946	9.899568	10.100432	34
27	9.793673	9.893845	9.899827	10.100173	33
28	9.793832	9.893745	9.900086	10.099913	32
29	9.793991	9.893645	9.900346	10.099654	31
30	9.794149	9.893544	9.900605	10.099395	30
	Co-sine	Sine	Co-tang.	Tangent	M

M	Sine	Co-sine	Tangent	Co-tang.	
30	9.794149	9.893544	9.900605	10.099395	30
31	9.794308	9.893444	9.900864	10.099135	29
32	9.794467	9.893343	9.901124	10.098876	28
33	9.794626	9.893243	9.901383	10.098617	27
34	9.794784	9.893142	9.901642	10.098358	26
35	9.794942	9.893041	9.901901	10.098099	25
36	9.795101	9.892940	9.902160	10.097839	24
37	9.795259	9.892839	9.902419	10.097580	23
38	9.795417	9.892738	9.902678	10.097321	22
39	9.795575	9.892637	9.902937	10.097062	21
40	9.795733	9.892536	9.903196	10.096803	20
41	9.795891	9.892435	9.903455	10.096544	19
42	9.796049	9.892334	9.903714	10.096285	18
43	9.796206	9.892233	9.903973	10.096027	17
44	9.796364	9.892132	9.904232	10.095768	16
45	9.796521	9.892030	9.904491	10.095509	15
46	9.796678	9.891929	9.904750	10.095250	14
47	9.796836	9.891827	9.905008	10.094991	13
48	9.796993	9.891726	9.905267	10.094733	12
49	9.797150	9.891624	9.905526	10.094474	11
50	9.797307	9.891522	9.905784	10.094215	10
51	9.797464	9.891421	9.906043	10.093957	9
52	9.797621	9.891319	9.906302	10.093698	8
53	9.797777	9.891217	9.906560	10.093440	7
54	9.797934	9.891115	9.906819	10.093181	6
55	9.798091	9.891013	9.907077	10.092923	5
56	9.798247	9.890911	9.907336	10.092664	4
57	9.798403	9.890809	9.907594	10.092406	3
58	9.798560	9.890707	9.907852	10.092147	2
59	9.798716	9.890605	9.908111	10.091889	1
60	9.798872	9.890503	9.908369	10.091631	0
M.	Co-sine.	Sine	Co-tang.	Tangent	M

Degree 51.

M	Sine	Co-sine	Tangent	Co-tang.	M
0	9.798872	9.890503	9.908369	10.091631	60
1	9.799028	9.890400	9.908627	10.091373	59
2	9.799184	9.890298	9.908886	10.091114	58
3	9.799339	9.890195	9.909144	10.090856	57
4	9.799495	9.890093	9.909402	10.090598	56
5	9.799651	9.889990	9.909660	10.090340	55
6	9.799806	9.889888	9.909918	10.090081	54
7	9.799961	9.889785	9.910176	10.089823	53
8	9.800117	9.889682	9.910435	10.089565	52
9	9.800272	9.889579	9.910693	10.089307	51
10	9.800427	9.889476	9.910951	10.089049	50
11	9.800582	9.889374	9.911209	10.088791	49
12	9.800737	9.889271	9.911467	10.088533	48
13	9.800892	9.889167	9.911724	10.088275	47
14	9.801047	9.889064	9.911982	10.088017	46
15	9.801201	9.888961	9.912240	10.087760	45
16	9.801356	9.888858	9.912498	10.087502	44
17	9.801510	9.888755	9.912756	10.087244	43
18	9.801665	9.888651	9.913014	10.086986	42
19	9.801819	9.888548	9.913271	10.086729	41
20	9.801973	9.888444	9.913529	10.086471	40
21	9.802127	9.888341	9.913787	10.086213	39
22	9.802282	9.888237	9.914044	10.085956	38
23	9.802435	9.888133	9.914302	10.085698	37
24	9.802589	9.888030	9.914560	10.085440	36
25	9.802743	9.887926	9.914817	10.085183	35
26	9.802897	9.887822	9.915075	10.084925	34
27	9.803050	9.887718	9.915332	10.084668	33
28	9.803204	9.887614	9.915590	10.084410	32
29	9.803357	9.887510	9.915847	10.084153	31
30	9.803510	9.887406	9.916104	10.083895	30
M	Co-sine.	Sine	Co-tang.	Tangent	M

M	Sine	Co-fine	Tangent	Co-tang.	
30	9.803510	9.887406	9.916104	10.083895	30
31	9.803664	9.887302	9.916362	10.083638	29
32	9.803817	9.887198	9.916619	10.083381	28
33	9.803970	9.887093	9.916876	10.083123	27
34	9.804123	9.887989	9.917134	10.082866	26
35	9.804276	9.886884	9.917391	10.082609	25
36	9.804428	9.886780	9.917648	10.082352	24
37	9.804581	9.886675	9.917905	10.082094	23
38	9.804734	9.886571	9.918162	10.081837	22
39	9.804886	9.886466	9.918420	10.081580	21
40	9.805038	9.886361	9.918677	10.081323	20
41	9.805191	9.886257	9.918934	10.081066	19
42	9.805343	9.886152	9.919191	10.080809	18
43	9.805495	9.886047	9.919448	10.080552	17
44	9.805647	9.885942	9.919705	10.080295	16
45	9.805799	9.885837	9.919962	10.080038	15
46	9.805951	9.885732	9.920219	10.079781	14
47	9.806103	9.885627	9.920476	10.079524	13
48	9.806254	9.885521	9.920733	10.079267	12
49	9.806406	9.885416	9.920990	10.079010	11
50	9.806557	9.885311	9.921247	10.078753	10
51	9.806709	9.885205	9.921503	10.078496	9
52	9.806860	9.885100	9.921760	10.078240	8
53	9.807011	9.884994	9.922017	10.077983	7
54	9.807162	9.884889	9.922274	10.077726	6
55	9.807314	9.884783	9.922530	10.077469	5
56	9.807464	9.884677	9.922787	10.077213	4
57	9.807615	9.884572	9.923044	10.076956	3
58	9.807766	9.884466	9.923300	10.076699	2
59	9.807917	9.884360	9.923557	10.076443	1
60	9.808067	9.884254	9.923813	10.076186	0
M	Co-fine	Sine	Co-tang.	Tangent	M

M	Sine	Co-sine	Tangent	Co-tang.	
0	9.808067	9.884254	9.923813	10.076186	60
1	9.808218	9.884148	9.924070	10.075930	59
2	9.808368	9.884042	9.924327	10.075673	58
3	9.808519	9.883936	9.924583	10.075417	57
4	9.808669	9.883829	9.924839	10.075160	56
5	9.808819	9.883723	9.925096	10.074904	55
6	9.808969	9.883617	9.925352	10.074647	54
7	9.809119	9.883510	9.925609	10.074391	53
8	9.809269	9.883404	9.925865	10.074135	52
9	9.809419	9.883297	9.926121	10.073878	51
10	9.809569	9.883191	9.926378	10.073622	50
11	9.809718	9.883084	9.926634	10.073366	49
12	9.809868	9.882977	9.926890	10.073110	48
13	9.810017	9.882871	9.927147	10.072853	47
14	9.810166	9.882764	9.927403	10.072597	46
15	9.810316	9.882657	9.927659	10.072341	45
16	9.810465	9.882550	9.927915	10.072085	44
17	9.810614	9.882443	9.928171	10.071829	43
18	9.810763	9.882336	9.928427	10.071573	42
19	9.810912	9.882228	9.928683	10.071317	41
20	9.810061	9.882121	9.928940	10.071060	40
21	9.811210	9.882014	9.929196	10.070804	39
22	9.811358	9.881907	9.929452	10.070548	38
23	9.811506	9.881799	9.929708	10.070292	37
24	9.811655	9.881692	9.929964	10.070036	36
25	9.811804	9.881584	9.930219	10.069781	35
26	9.811952	9.881477	9.930475	10.069525	34
27	9.812100	9.881369	9.930731	10.069269	33
28	9.812248	9.881261	9.930987	10.069013	32
29	9.812396	9.881153	9.931243	10.068757	31
30	9.812544	9.881045	9.931499	10.068501	30
	Co-sine	Sine	Co-tang.	Tangent	M

Degree 55.

Degree 40. 499

M	Sine	Co-sine	Tangent	Co-tang.	
30	9.812544	9.881045	9.931499	10.068501	30
31	9.812692	9.880937	9.931755	10.068245	29
32	9.812840	9.880829	9.932010	10.067989	28
33	9.812988	9.880721	9.932266	10.067734	27
34	9.813135	9.880613	9.932522	10.067478	26
35	9.813283	9.880505	9.932778	10.067222	25
36	9.813430	9.880397	9.933033	10.066967	24
37	9.813578	9.880289	9.933289	10.066711	23
38	9.813725	9.880180	9.933545	10.066455	22
39	9.813872	9.880072	9.933800	10.066200	21
40	9.814019	9.879963	9.934056	10.065944	20
41	9.814166	9.879855	9.934311	10.065688	19
42	9.814313	9.879746	9.934567	10.065433	18
43	9.814460	9.879637	9.934822	10.065177	17
44	9.814607	9.879529	9.935078	10.064922	16
45	9.814753	9.879420	9.935333	10.064666	15
46	9.814900	9.879311	9.935589	10.064411	14
47	9.815046	9.879202	9.935844	10.064156	13
48	9.815193	9.879093	9.936100	10.063900	12
49	9.815339	9.878984	9.936355	10.063645	11
50	9.815485	9.878875	9.936610	10.063389	10
51	9.815631	9.878766	9.936866	10.063134	9
52	9.815777	9.878656	9.937121	10.062879	8
53	9.815923	9.878547	9.937376	10.062623	7
54	9.816069	9.878438	9.937632	10.062368	6
55	9.816215	9.878328	9.937887	10.062113	5
56	9.816361	9.878219	9.938142	10.061858	4
57	9.816506	9.878109	9.938397	10.061602	3
58	9.816652	9.877999	9.938653	10.061347	2
59	9.816797	9.877890	9.938908	10.061092	1
60	9.816943	9.877780	9.939163	10.060837	0
M	Co-sine	Sine	Co-tang.	Tangent	M

Degree 49.

M	Sine	Co-sine	Tangent	Co-tang.	
0	9.816943	9.877780	9.939163	10.060837	60
1	9.817088	9.877679	9.939418	10.060582	59
2	9.817233	9.877569	9.939673	10.060327	58
3	9.817378	9.877459	9.939928	10.060072	57
4	9.817523	9.877349	9.940183	10.059816	56
5	9.817668	9.877239	9.940438	10.059562	55
6	9.817813	9.877129	9.940693	10.059307	54
7	9.817958	9.877009	9.940948	10.059052	53
8	9.818103	9.876899	9.941203	10.058797	52
9	9.818247	9.876789	9.941458	10.058542	51
10	9.818392	9.876678	9.941713	10.058287	50
11	9.818536	9.876568	9.941968	10.058032	49
12	9.818681	9.876457	9.942223	10.057777	48
13	9.818825	9.876347	9.942478	10.057522	47
14	9.818969	9.876236	9.942733	10.057267	46
15	9.819113	9.876125	9.942988	10.057012	45
16	9.819257	9.876014	9.943243	10.056757	44
17	9.819401	9.875904	9.943498	10.056502	43
18	9.819545	9.875793	9.943752	10.056248	42
19	9.819689	9.875682	9.944007	10.055993	41
20	9.819832	9.875571	9.944262	10.055728	40
21	9.819976	9.875459	9.944517	10.055483	39
22	9.820119	9.875348	9.944771	10.055229	38
23	9.820263	9.875237	9.945026	10.054974	37
24	9.820406	9.875125	9.945281	10.054719	36
25	9.820549	9.875014	9.945535	10.054464	35
26	9.820693	9.874903	9.945790	10.054210	34
27	9.820836	9.874791	9.946045	10.053955	33
28	9.820979	9.874679	9.946299	10.053701	32
29	9.821122	9.874568	9.946554	10.053446	31
30	9.821264	9.874456	9.946808	10.053192	30
M	Co-sine	Sine	Co-tang.	Tangent	M

M	Sine	Co-sine	Tangent	Co-tang.	
30	9.821264	9.874456	9.946808	10.053192	30
31	9.821407	9.874344	9.947063	10.052937	29
32	9.821550	9.874232	9.947317	10.052684	28
33	9.821692	9.874120	9.947572	10.052428	27
34	9.821835	9.874008	9.947826	10.052173	26
35	9.821977	9.873896	9.948081	10.051919	25
36	9.822120	9.873784	9.948335	10.051664	24
37	9.822262	9.873672	9.948590	10.051410	23
38	9.822404	9.873560	9.948844	10.051156	22
39	9.822546	9.873447	9.949099	10.050901	21
40	9.822688	9.873335	9.949353	10.050647	20
41	9.822830	9.873223	9.949607	10.050393	19
42	9.822972	9.873110	9.949862	10.050138	18
43	9.823114	9.872998	9.950116	10.049884	17
44	9.823255	9.872885	9.950370	10.049630	16
45	9.823397	9.872772	9.950625	10.049375	15
46	9.823538	9.872659	9.950879	10.049121	14
47	9.823680	9.872546	9.951133	10.048867	13
48	9.823821	9.872434	9.951388	10.048612	12
49	9.823962	9.872321	9.951642	10.048358	11
50	9.824104	9.872208	9.951896	10.048104	10
51	9.824245	9.872094	9.952150	10.047850	9
52	9.824386	9.871981	9.952404	10.047575	8
53	9.824527	9.871868	9.952659	10.047341	7
54	9.824667	9.871755	9.952913	10.047087	6
55	9.824808	9.871641	9.953167	10.046833	5
56	9.824949	9.871528	9.953421	10.046579	4
57	9.825090	9.871414	9.953675	10.046325	3
58	9.825230	9.871301	9.953929	10.046071	2
59	9.825370	9.871187	9.954183	10.045817	1
60	9.825511	9.871073	9.954437	10.045563	0
	Co-sine	Sine	Co-tang.	Tangent	M

M	Sine	Co-sine	Tangent	Co-tang.	
0	9.825511	9.871073	9.954437	10.045562	60
1	9.825651	9.870960	9.954691	10.045308	59
2	9.825791	9.870846	9.954945	10.045054	58
3	9.825931	9.870732	9.955199	10.044800	57
4	9.826071	9.870618	9.955453	10.044546	56
5	9.826211	9.870504	9.955707	10.044292	55
6	9.826351	9.870390	9.955961	10.043038	54
7	9.826491	9.870275	9.956215	10.043784	53
8	9.826631	9.870161	9.956469	10.043531	52
9	9.826770	9.870047	9.956723	10.043276	51
10	9.826910	9.869933	9.956977	10.043023	50
11	9.827049	9.869818	9.957231	10.042769	49
12	9.827189	9.869704	9.957485	10.042515	48
13	9.827328	9.869589	9.957739	10.042261	47
14	9.827467	9.869474	9.957993	10.042007	46
15	9.827606	9.869360	9.958246	10.041753	45
16	9.827745	9.869245	9 958500	10.041500	44
17	9.827884	9.869130	9.958754	10.041246	43
18	9.828023	9.869015	9.959008	10 040992	42
19	9.828162	9.868900	9.959262	10.040738	41
20	9.828301	9.868785	9.959515	10.040485	40
21	9.828439	9.868670	9.959769	10.040231	39
22	9.828578	9.868555	9.960023	10.039977	38
23	9.828716	9.868439	9.960277	10.039723	37
24	9.828855	9.868324	9.960530	10.039469	36
25	9.828993	9.868209	9.960784	10.039216	35
26	9.829131	9.868093	9.961038	10.038962	34
27	9.829269	9.867978	9.961291	10.038608	33
28	9.829407	9.867862	9.961545	10.038451	32
29	9.829545	9.867747	9 961799	10.038201	31
30	9.829683	9.867631	9.962052	10.037947	30
	Co-sine	Sine	Co-tang.	Tangent	M

M	Sine	Co-sine	Tangent	Co-tang.	
30	9.829683	9.867631	9.962052	10.037947	30
31	9.829821	9.867515	9.962306	10.037694	29
32	9.829959	9.867399	9.962560	10.037440	28
33	9.830096	9.867283	9.962813	10.037187	27
34	9.830234	9.867167	9.963067	10.036933	26
35	9.830372	9.867051	9.963320	10.036680	25
36	9.830509	9.866935	9.963574	10.036426	24
37	9.830646	9.866819	9.963827	10.036173	23
38	7.830784	9.866703	9.964081	10.035919	22
39	9.830921	9.866586	9.964335	10.035665	21
40	9.831058	9.866470	9.964588	10.035412	20
41	9.831195	9.866353	9.964842	10.035158	19
42	9.831332	9.866237	9.965095	10.034905	18
43	9.831469	9.866120	9.965348	10.034652	17
44	9.831606	9.866004	9.965602	10.034398	16
45	9.831742	9.865887	9.965855	10.034144	15
46	9.831879	9.865770	9.966109	10.033891	14
47	9.832015	9.865658	9.966362	10.033638	13
48	9.832152	9.865536	9.966616	10.033384	12
49	9.832288	9.865419	9.966869	10.033131	11
50	9.832425	9.865302	9.967122	10.032878	10
51	9.832561	9.865185	9.967376	10.032624	9
52	9.832697	9.865068	9.967629	10.032371	8
53	9.832833	9.864950	9.967883	10.032117	7
54	9.832969	9.864833	9.968136	10.031864	6
55	9.833105	9.864716	9.968389	10.031611	5
56	9.833241	9.864598	9.968643	10.031357	4
57	9.833376	9.864480	9.968896	10.031104	3
58	9.833512	9.864363	9.969149	10.030851	2
59	9.833648	9.864245	9.969403	10.030597	1
60	9.833783	9.864127	9.969656	10.030344	0
	Co-sine.	Sine	Co-tang.	Tangent	M

Degree 47.

M	Sine	Co-sine	Tangent	Co-tang.	
0	9.833783	9.864127	9.969656	10.030344	60
1	9.833919	9.864010	9.969909	10.030091	59
2	9.834054	9.863892	9.970162	10.029838	58
3	9.834189	9.863774	9.970416	10.029584	57
4	9.834324	9.863656	9.970669	10.029331	56
5	9.834460	9.863537	9.970922	10.029078	55
6	9.834595	9.863419	9.971175	10.028827	54
7	9.834730	9.863301	9.971428	10.028571	53
8	9.834865	9.863183	9.971682	10.028318	52
9	9.834999	9.863064	9.971935	10.028065	51
10	9.835134	9.862946	9.972188	10.027812	50
11	9.835269	9.862827	9.972441	10.027559	49
12	9.835503	9.862709	9.972694	10.027306	48
13	9.835538	9.862590	9.972948	10.027052	47
14	9.835672	9.862471	9.973201	10.026799	46
15	9.835806	9.862353	9.973454	10.026546	45
16	9.835941	9.862234	9.973707	10.026293	44
17	9.836075	9.862115	9.973960	10.026040	43
18	9.836209	9.861996	9.974213	10.025787	42
19	9.836343	9.861877	9.974466	10.025533	41
20	9.836477	9.861757	9.974719	10.025280	40
21	9.836611	9.861638	9.974973	10.025027	39
22	9.836745	9.861519	9.975229	10.024774	38
23	9.836878	9.861399	9.975479	10.024521	37
24	9.837012	9.861280	9.975732	10.024268	36
25	9.837146	9.861161	9.975985	10.024015	35
26	9.837279	9.861041	9.976238	10.023762	34
27	9.837412	9.860921	9.976491	10.023509	33
28	9.837546	9.860802	9.976744	10.023256	32
29	9.837679	9.860682	9.976997	10.023003	31
30	9.837812	9.860562	9.977250	10.022750	30
	Co-sine.	Sine	Co-tang.	Tangent	M

Degree 43. 405

M	Sine	Co-sine	Tangent	Co-tang.	
30	9.837812	9.860562	9.977250	10.022750	30
31	9.837945	9.860442	9.977503	10.022497	29
32	9.838078	9.860322	9.977756	10.022244	28
33	9.838211	9.860202	9.978009	10.021991	27
34	9.838344	9.860082	9.978262	10.021738	26
35	9.838477	9.859962	9.978515	10.021485	25
36	9.838609	9.859842	9.978768	10.021232	24
37	9.838742	9.859721	9.979021	10.020979	23
38	9.838875	9.859601	9.979274	10.020726	22
39	9.839007	9.859480	9.979527	10.020473	21
40	9.839140	9.859360	9.979780	10.020220	20
41	9.839272	9.859239	9.980033	10.019967	19
42	9.839484	9.859118	9.980285	10.019714	18
43	9.839536	9.858998	9.980538	10.019461	17
44	9.839668	9.858877	9.980791	10.019209	16
45	9.839800	9.858756	9.981044	10.018956	15
46	9.839932	9.858639	9.981297	10.018703	14
47	9.840064	9.858514	9.981550	10.018450	13
48	9.840196	9.858398	9.981803	10.018197	12
49	9.840428	9.858272	9.982056	10.017944	11
50	9.840459	9.858150	9.982309	10.017691	10
51	9.840591	9.858029	9.982562	10.017438	9
52	9.840722	9.857908	9.982814	10.017185	8
53	9.840854	9.857786	9.983067	10.016933	7
54	9.840985	9.857665	9.983320	10.016683	6
55	9.841116	9.857543	9.983573	10.016427	5
56	9.841247	9.857421	9.983826	10.016174	4
57	9.841378	9.857300	9.984079	10.015921	3
58	9.841509	9.857178	9.984331	10.015668	2
59	9.841640	9.857056	9.984584	10.015416	1
60	9.841771	9.856934	9.984837	10.015163	0
	Co-sine	Sine	Co-tang.	Tangent	M

Degree 46.

506 Degree 44

M	Sine	Co-sine	Tangent	Co-tang.	
0	9.841771	9.856934	9.984837	10.015162	60
1	9.841902	9.856812	9.985090	10.014910	59
2	9.842033	9.856690	9.985343	10.014657	58
3	9.842163	9.856568	9.985596	10.014404	57
4	9.842294	9.856445	9.985848	10.014151	56
5	9.842424	9.856323	9.986101	10.013899	55
6	9.842555	9.856201	9.986354	10.013646	54
7	9.842685	9.856078	9.986607	10.013393	53
8	9.842815	9.855956	9.986859	10.013140	52
9	9.842945	9.855833	9.987112	10.012888	51
10	9.843076	9.855710	9.987365	10.012635	50
11	9.843206	9.855588	9.987618	10.012382	49
12	9.843336	9.855465	9.987871	10.012129	48
13	9.843465	9.855342	9.988123	10.011877	47
14	9.843595	9.855219	9.988376	10.011624	46
15	9.843725	9.855096	9.988629	10.011371	45
16	9.843855	9.854973	9.988882	10.011118	44
17	9.843934	9.854850	9.989134	10.010866	43
18	9.844114	9.854727	9.989387	10.010613	42
19	9.844243	9.854603	9.989640	10.010360	41
20	9.844372	9.854480	9.989893	10.010107	40
21	9.844502	9.854356	9.990145	10.009855	39
22	9.844631	9.854233	9.990398	10.009602	38
23	9.844760	9.854109	9.990651	10.009349	37
24	9.844889	9.853986	9.990903	10.009096	36
25	9.845018	9.853862	9.991156	10.008844	35
26	9.845147	9.853738	9.991409	10.008591	34
27	9.845276	9.853614	9.991662	10.008338	33
28	9.845404	9.853490	9.991914	10.008086	32
29	9.845533	9.853366	9.992167	10.007833	31
30	9.845662	9.853242	9.992420	10.007580	30
	Co-sine	Sine	Co-tang.	Tangent	M

Degree 45.

M	Sine	Co-sine	Tangent	Co-tang.	
30	9.845662	9.853242	9.992420	10.007580	30
31	9.845790	9.853118	9.992672	10.007328	29
32	9.845919	9.852994	9.992925	10.007075	28
33	9.846047	9.852869	9.993178	10.006822	27
34	9.846175	9.852745	9.993430	10.006569	26
35	9.846304	9.852620	9.993683	10.006317	25
36	9.846432	9.852496	9.993936	10.006064	24
37	9.846560	9.852371	9.994189	10.005811	23
38	9.846688	9.852246	9.994441	10.005559	22
39	9.846816	9.852122	9.994694	10.005306	21
40	9.846944	9.851997	9.994947	10.005053	20
41	9.847071	9.851872	9.995199	10.004801	19
42	9.847199	9.851747	9.995452	10.004548	18
43	9.847327	9.851622	9.995701	10.004295	17
44	9.847454	9.851497	9.995957	10.004043	16
45	9.847582	9.851372	9.996210	10.003790	15
46	9.847709	9.851246	9.996463	10.003537	14
47	9.847836	9.851121	9.996715	10.003285	13
48	9.847964	9.850996	9.996968	10.003032	12
49	9.848091	9.850870	9.997220	10.002779	11
50	9.848218	9.850745	9.997473	10.002527	10
51	9.848345	9.850619	9.997726	10.002274	9
52	9.848472	9.850493	9.997979	10.002021	8
53	9.848599	9.850367	9.998231	10.001769	7
54	9.848726	9.850242	9.998484	10.001516	6
55	9.848852	9.850116	9.998737	10.001263	5
56	9.848979	9.849990	9.998989	10.001011	4
57	9.849106	9.849864	9.999242	10.001758	3
58	9.849232	9.849737	9.999495	10.000505	2
59	9.849359	9.849611	9.999747	10.000253	1
60	9.849485	9.849485	10.000000	10.000000	0
	Co-sine	Sine	Co-tang.	Tangent	M

Degree 45.

FINIS.

Some Books ſold by W. Freeman *at the* Artichoke *next St.* Dunſtan's *Church in* Fleet-ſtreet.

REports in the Court of King's-Bench from the 12*th.* to the 30*th.* Year of the Reign of our late Sovereign Lord King *Charles* II. in 3 Vol. Taken by *J. Keble* of *Grey's-Inn*, Eſquire; with new and uſefull Tables to all the 3 Vol.

Sheppard's Preſident of Preſidents. 8°.

Zenophon's Hiſtory of the Affairs of *Greece*, in ſeven Books, being a Continuation of the *Peloponneſian* War, from the time where *Thucydides* ends, to the Battel at *Mantinea*; to which is prefixed an Abſtract of *Thucydides*, and a brief Account of the Land and Naval Forces of the ancient *Greeks*. Tranſlated from the *Greek* by *John Newman*.

The Inſtitution and Life of *Cyrus* the Great, written by the famous Philoſopher and General, *Zenophon* of *Athens*. Tranſlated by *F. Digby* and *J. Norris*.

Holy Devotions with Directions to Pray: Alſo a Brief Expoſition on the Lord's Prayer, Creed, Ten Commandments, ſeven Penitential Pſalms, and the ſeven Pſalms of Thankſgiving, by the Right Reverend Father in God *Lancelot Andrews* late Biſhop of *Winchester*.

Daily Exerciſe for a Chriſtian, or a Manual of Private Devotions, as well for every day in the Week, as upon Particular Occaſions, by *J. Bridal*, Senior, Eſq; late of the Rolls.

A New Years Gift compoſed of Prayers and Meditations with Devotions for ſeveral Occaſions; the whole ſix parts compleat.

The

The *Old Religion:* A Treatiſe wherein is laid down the true State of the Difference betwixt the *Reformed* and *Roman Church.* Serving *for the Vindication of Our Innocence, for the ſetling of Wavering Minds, for a Preſervation againſt Popiſh Inſinuations.* By the Reverend Father in God *Joſ. Hall* late Lord Biſhop of *Exceſter*, and afterwards of *Norwich.*

The *Manners of the Iſraelites in* 3 parts. 1. Of the *Patriarchs.* 2. Of the *Iſraelites*, after their coming out of *Egypt*, untill the *Captivity* of *Babylon.* 3. Of the *Jews*, after their Return from the Captivity, untill the Preaching of the Goſpel, in 12°.

The *Means to preſerve Peace in Marriage*; being an ingenious Treatiſe written (Originally in *French*) by the Authour of the *Rules* of *Civility.*

The Penitent Pardoned, or a Diſcourſe of the Nature of Sin and Efficacy of Repentance, under the Parable of the Prodigal Son, by Dr. *Goodman.*

An infallible way to Contentment in the midſt of Publick and Perſonal Calamities, together with the Chriſtians Courage and Encouragement againſt evil Tidings and the fear of Death.

Argalus and *Parthenia*, by *F. Quarles.*

Nanis Hiſtory of *Venice*, Fol.

Hiſtory of the Government of *Venice*, 8°.

Policy of the *Venetians*, 12°.

The Miſtaken Beauty, a Comedy.

The Dutcheſs of *Malphey.*

The Empreſs of *Morocco*, a Farce.

The Court of the Gentiles in 4 parts compleat, by *Theophilus Gale.*